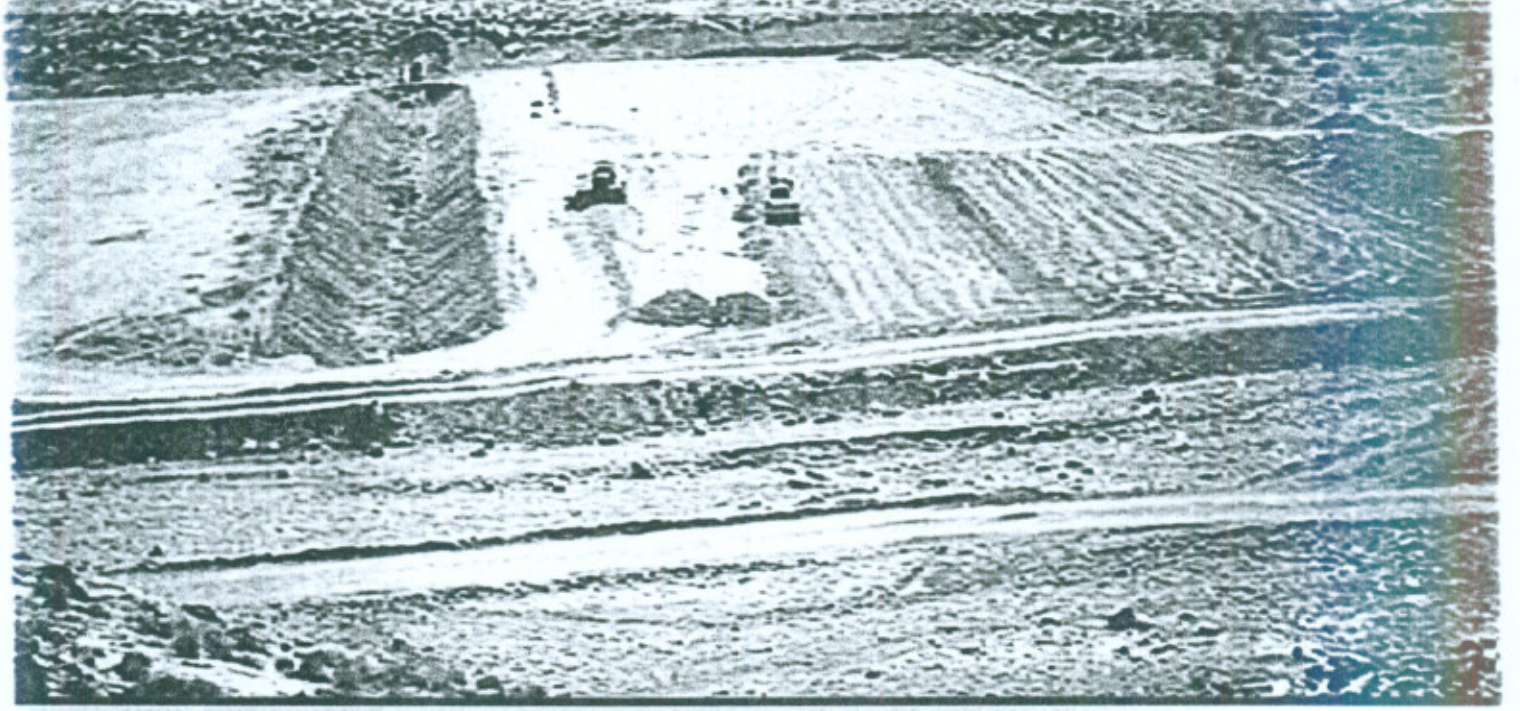
Engineering News

A Quarterly Journal of the Pakistan Engineering Congress

Vol: 42 October - December 2004 No: 3





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COVER PHOTO

Top : A view of Maidani Dam (FATA) where construction is in progress.
Bottom : Proposed Balochistan University of Information, Technology and Management Science, Quetta.

46th YEAR OF PUBLICATION

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Editorial

INCREASING DEATHS ON ROADS

Within the intervening period of this issue and the last one a large number of road users have died. A marriage party loses 21 members over Chichawatni Road Bridge; what a misery for the community? The only son of an army colonel dies after crashing against a government water tanker parked on the wrong side of the road on main boulevard, Gulberg, Lahore; what a loss to the bereaved family? A family of five moving from Bahawalpur to nearby village crushed to death along with the taxi driver right in the cantonment area; what a destiny? Countless accidents take place every day, some reported by the newspapers, others go unnoticed. All are forgotten soon after religious rites except by the close relatives particularly parents, widows and orphans who carry the pain for the rest of their lives. The question arises should we forget them? The readers will readily exclaim No! Even the killers should not be forgotten and forgiven. They should be taken to task and punished.

Effectees in the heart of their hearts expect the road engineers to remember them while planning and designing the roads and bridges for curves and curvatures and the road safety features and the transport officials for rightly placed sign boards to lead them to their destinations and not to death. Accident over Chichawatni Bridge is not the first one which can be lost to routine investigations. Numerous accidents have taken place when buses and other vehicles have fallen from bridges into canals, rivers and ravines. Vehicles parked wrongly and un-necessarily on the road have also resulted in many accidents and, of course, main reason of accidents is the wrong signalling or no signalling by drivers or not following the traffic control signals. In this case all who do not go by the traffic discipline are guilty of chaos on the roads. All will agree that we need to have patience and vigilance on the roads. At this juncture there is another question, who will teach us the road using manners?

All those who are responsible for planning, designing, controlling and using the roads have to be responsible for that and hopefully;

(a) *The traffic police* by applying the strict controls for sanctioning driving licenses, by sparing more time and staff to the public service rather to the restricted number of VIPs.

(b) *The NGOs* who should provide education and spread awareness. This is a vast and vital field where injuries to the road users can be avoided and deaths eliminated by education and awareness.

(c) *The schools and colleges* by teaching road manners to the students. All have their rights and responsibilities for moving on the road, the pedestrian, the cyclist and the drivers.

(d) *The parents* by not permitting the minors to drive vehicles. Some parents feel proud of their children's driving skills without foreseeing the consequential results.

(e) *The senior citizen* by counseling the juniors at home, to walk

groups, in mosques and religious gatherings and parks.

(f) *All and sundry* by adequate learning driving and applying their skills carefully on the road and to keep their vehicles in road worthy condition.

However the basic responsibility lies with the government and its departments for education and awareness, providing training and licensing particularly to the drivers and pedestrians in general.

Gone are the days when a cyclist was not permitted to move on the road without a light. Imagine the present situation where even the fast moving vehicles are not equipped with adequate lights, indicators and reflectors and per chance whose vehicles have lights, drivers do not care to use them for the relevant signalling. It is a pity that we have lost the sense to follow the instructions and enforce the regulations so much so that equipments, iron bars and other materials project out of the vehicles endangering the live of other road users. Is this the legacy of this generation that it would like to pass to next one?

This is the most important question of all. We should endeavor finding an answer in the fact that success of traffic control and discipline reflects on the personal behavior of the individuals and national character at large. All accidents must be investigated for failure to be assigned to particular factor i.e. to the properties of the road, vehicle design or administrative and design neglect. Regular assessment of the failures be reported to the government, press and public for lessons to be learnt by all concerned for remedial measures. Remember that life is very important in Islam. Killing one tantamounts to killing whole of humanity and by extension saving lives by act of improving road traffic will bring God Almighty's mercy, forgiveness and success in the life hereafter. Remember in this life, by properly controlling traffic abiding by the rules, we can save precious lives.

It is worth trying.

News

BIODEGRADABLE PLASTIC BAGS INTRODUCED WITH "CONTROLLED LIFETIME"

A Quebec-based company has introduced to the market a line of plastic bags that it says allows consumers to choose over what period of time the bags will degrade. The Company says that after an extensive test program, it's the first Canadian company ready to provide customers with "environmental friendly plastic bags designed with a controlled lifetime".

According to available statistics, millions of tons of single-use plastic products are sent to landfills every year. This waste is expected to accumulate for decades, contrary to the principles of sustainable development.

"Plastic bags will degrade in as little time as a few months to five years when discarded as the additive accelerates the oxidation of the plastic", the Company claims. The degradation process, triggered by UV light, heat, moisture or stress, occurs at a rate tailored to the buyer's requirements, breaking down over a period of months or years. Once the plastic begins to oxidize, it becomes brittle and susceptible to the usual agents of degradation, such as moisture and microbes.

Source : Omniplast Inc. St. Hubert, Quebec, Canada

MUNCHING MICROBES COULD CLEANSE ARSENIC-CONTAMINATED GROUNDWATER

Microbial processors ultimately determine whether arsenic builds to dangerous levels in groundwater, say researchers at the University of Illinois at Urbana-Champaign. Remediation may be as simple as stimulating certain microbes to grow.

Arsenic contamination is a serious threat to human health in many parts of the world. In the Ganges Delta of Bangladesh, for example, chronic exposure to arsenic has been linked to serious medical conditions, including hypertension, cardiovascular disease and a variety of cancers.

Important links between the amount of organic material dissolved in the groundwater and the concentrations of sulfate and arsenic has been discovered. The concentration of arsenic varied inversely with the concentration of sulfate. Sulfate-reducing bacteria will consume sulfate and reduce it into sulfide. The sulfide then reacts to precipitate arsenic, leaving little in solution. If the sulfate-reducing bacteria run out of sulfate, methanogenic bacteria take over as the dominant metabolic force. Because methanogenic bacteria don't produce sulfide, there is no precipitation pathway for the arsenic, which then accumulates to high levels in the groundwater.

Where the supply of sulfate is high, sulfate remains available and sulfate-reducing bacteria keep arsenic levels low. Where the sulfate has been depleted, and arsenic may "accumulate".

There is good news, however. The researchers' findings suggest that groundwater contaminated with arsenic might be easily identified and remediated. Unlike detecting the presence of arsenic – which generally requires a sensitive laboratory analysis – testing for sulfate is simple and straightforward.

Adding sulfate to naturally contaminated groundwater might be a simple but effective method to sequester the arsenic. "The bacteria are already present, so all you have to do is stimulate them". Sulfate salts, he said, are inexpensive, readily soluble and easily obtained.

Source : University of Illinois at Urbana-Champaign

News on Consultants Activities

NESPAK

NESPAK Engaged for the Second Container Terminal at Port Qasim

Port Qasim International Container Terminal Ltd. has engaged NESPAK for preparation of a design report and proposal for the construction of a second container terminal at Port Qasim. The terminal will require construction of new berths and container storage yards on reclaimed land along with all related infrastructure facilities, container handling, ship to shore gantry cranes, rubber tyred gantry cranes and other equipment for handling of 500,000 TEUs/annum.

Construction of Mangla Dam Raising Initiated

The Rs. 13.8 million contract for 30 ft. raising of Mangla Dam was signed between China International Water and Electric Corporation (CWE) Joint Venture and WAPDA. The JV is led by Chinese contractor CWE. The dam raising is scheduled to be completed by September 2007 and the major components of works include 30 ft. raising of Mangla Dam, intake embankment, Sukian dyke and Jari dam, raising of main spillway head works by 30 ft. and reducing the height of its nine gated orifices by 35-40 ft. A concrete control weir with a height of about 60 ft. above its foundation will be constructed in approach channel of the emergency spillway. Construction of an 18 km long Mirpur bypass road also forms part of the contract.

Mangla Joint Venture Consultants with NESPAK as the lead firm have been involved in feasibility studies, detailed engineering and tendering of the project since August 2000. MJV is

now providing construction supervision services for the project.

Bibi Jawandi Tomb Complex, Uch Sharif

NESPAK is providing consultancy services for the rehabilitation of the dilapidated Bibi Jawandi Tomb Complex at Uch Sharif to M/s Conservation and Rehabilitation Centre. This structure has been declared as one of the world's hundred most endangered archeological structures by the World Monumental Fund. It is a national heritage of world recognition.

The project involves detailed material, geotechnical and structural studies and suggesting solutions for rehabilitation.

Phase-II and III of PICT Terminal Awarded To NESPAK

After successful completion of Phase-I of the Pakistan International Container Terminal at Karachi Port, NESPAK has been awarded the design and construction supervision services of Phase-II and III. With the completion of Phase-I, the terminal is now fully functional with modern equipment for efficient loading / unloading of container cargo, which include two Quayside and four Rubber Tyred Gantry Cranes and other container yard handling equipment. The facilities also include a new 4.8 MW powerplant. Phase-II and III works include detailed design of access bridge, buildings, water works, sewage treatment plant and other facilities, procurement and installation of additional Quayside and Rubber Tyred Gantry Cranes.

Lahore Ring Road Project Awarded to NESPAK

NESPAK has been awarded the Lahore Ring Road project by Communication and Works Department, Government of the Punjab.

The Ring Road will encircle the city. It will be 75 to 80 km in length and will provide a closed loop for the commuters relieving the congestion on many existing radial routes. Additionally some radial routes will also be upgraded as part of the project. The proposed Ring Road shall reduce travel time and will result in savings in vehicle operating cost.

Construction Starts on the Punjab Government Servants Housing Scheme Mohlanwal, Lahore

NESPAK entered into an agreement in January 2004 with Housing, Urban Development and Public Health Engineering Department, Government of the Punjab for providing consultancy services for design and construction supervision for the Punjab Government Servants Housing Scheme at Mohlanwal, Lahore. The project cost is Rs. 1,890 million and construction has started since September 2004.

Construction supervision for a similar scheme in Faisalabad has also been awarded to NESPAK with a project cost of Rs. 2,600 million.

Design and Construction Supervision Starts on Four of the 12 Dams in FATA

The job of design and construction supervision of twelve dams in FATA was awarded to NESPAK by the Governor's Secretariat, FATA. The construction work has started on four dams for which the design, tender documentation and construction drawings were prepared by NESPAK. These four dams include Kot Ragha dam and Maidani dam in the Kurram Agency and Marsi Khel dam and Mir Kalam dam in the North Waziristan Agency.

NESPAK Awarded the Preparation of Sewerage Master Plan and Detailed Design for Priority Areas of Rahim Yar Khan City

The Housing, Urban Development and Public Health Engineering Department (HUD and PHED), Government of the Punjab, has engaged NESPAK for preparation of a Sewerage Master Plan for Rahim Yar Khan city including detailed design for priority areas. The consultancy services to be rendered include survey, study and review of the existing sewerage system, geotechnical investigations, preparation of detailed design and tender documents.

NESPAK Wins Infrastructure Development Works of Quaid-e-Azam Industrial Estate, Lahore

A Memorandum of Understanding was signed on July 24, 2004 for the Quaid-e-Azam Industrial Estate between the Punjab Industrial Estates Development and Management Company and NESPAK. Advisor to Chief Minister Punjab, Mr. Jahangir Tareen, Dr. Amjad Parvez Sheikh, Managing Director NESPAK, Mr. Umar Aslam, Vice President (Coordination) and Mr. M.P. Aftab Vice President, Environmental and Public Health Engineering Division along with his staff participated in the MoU signing ceremony. The NESPAK's scope of work comprises complete refurbishment and improvement of the infrastructure of the industrial estate. The project has three months completion time for design and tender documents, followed by an eighteen months time for the actual implementation. Topographic surveys and geotechnical investigations have been completed and the preliminary design report has been submitted to the Client.

Work on International Islamic University, Islamabad in Progress

NESPAK has been engaged on the design and supervision of Phase-II facilities of International Islamic University at Islamabad. The construction of a library block is in progress whereas the University has approved the design of administration block. The building comprises 4 floors with the covered area of 85,000 sft.

Bulk Water Supply from River Jehlum to New Hill Resort at Patriata Awarded

The Government of the Punjab had decided to develop a new Township near Patriata. The Housing, Urban Development and Public Health Engineering Department (HUD and PHED) awarded NESPAK the work of detailed design of Bulk Water Supply from River Jhelum to the New Hill Resort at Patriata.

The project aims at pumping water from River Jhelum, 22 km away, to the proposed Patriata township at a height of 1,830 meters. The project will be implemented in two phases to meet the water requirements up to year 2025 (5.5 MGD) and up to 2050 (11.00 MGD).

NESPAK Appointed as Consultant for Sector G-14/4, Islamabad

Federal Government Employees Housing Foundation has engaged NESPAK for providing consultancy services for the development of Sector G-14/4 of Islamabad. The project covers an area of about 200 Acres and development works are estimated to cost Rs. 240 million. The NESPAK scope of work covers complete range of consultancy services including designing of roads, water supply, sewerage, drainage, underground electrification works, contract management and detailed construction supervision.

NESPAK Selected for KPT's Staff Housing Scheme

Karachi Port Trust has issued a Letter of Intent to NESPAK for consultancy work on the proposed KPT Staff Housing Scheme at Hawkes Bay- Port Town. This was made possible after NESPAK's technical proposal was rated as the best by the Managing Committee of Port Town scheme.

The project site is located along the Hawkes Bay road and is spread over about 500 acres. The project envisages housing facilities for approximately 13,000 employees. NESPAK services will cover topographic surveys, master planning and detailed design.

NESPAK to Conduct Feasibility Study for 150 MW CCPP Project Korangi, Karachi

NESPAK in association with Lahmeyer International will conduct detailed feasibility study for establishing a 150 MW Combined Cycle Thermal Power Plant (CCPP) for Fauji Foundation. The project will be located at Korangi, Karachi. Both natural gas and furnace oil would be considered as potential fuels.

The scope of work comprises development of optimum layout of the combined cycle powerplant based on the results of existing pre-feasibility study. The resulting layout shall include the basic conceptual design of the mechanical and electrical equipment and systems, the hardware and software needed for a computer-based plant control, as well as of the civil works.

The least-cost solution for the power station is to be determined, meeting the environmental standards and licensing requirements.

Consulting Services for Sahiwal 500 kV Substation Project Awarded to NESPAK

National Transmission and Dispatch Company, WAPDA has awarded to NESPAK the consulting services for upgrading the existing 220/ 132 kV Sahiwal substation to 500 kV voltage level. The project comprises two 500 kV line bays along with shunt reactors, two 3 x 200 MVA 500/220 kV power transformers with one spare unit along with 220 kV associated equipment, one 220 kV line bay and associated protection equipment.

The scope of services includes design, preparation of bidding documents, evaluation of bids, award of contract and supervision of construction works.

KESC Awards Study for Conversion of Gas Turbine Station to Combined Cycle Block

KESC has engaged NESPAK for providing consulting services to study and examine 125 MW gas turbine power station at SITE, Karachi.

The main objective of the study is to examine the possibility of converting the existing open cycle gas turbine units into combined cycle block, with due regard to the residual life of the units, their ageing and general operational condition of the units and ancillary equipment. Importance is to be given to the source and adequacy of cooling water, space limitation and other relevant factors so as to ascertain the viability of the proposed scheme from technical and economic points of view.

NESPAK Awarded Construction/ Reno-vation and Detailed Supervision of BUITMS Takatu Campus at Quetta

NESPAK has been awarded construction / renovation and detailed supervision of BUITMS Takatu Campus by Balochistan University of Information Technology and Management Science, Quetta. The new Campus shall be constructed within the existing structure of defunct Bolan Textiles Mills located at Baleli, Quetta. It will accommodate departments of Engineering and Applied Sciences, when completed.

A presentation was made by Mr. Asad I. A. Khan, Vice President (AandP) Karachi to the Honourable Governor of Balochistan, Mr. Owais Ahmad Ghani, on July 27, 2004 at Governor House, Quetta. Dr. Amjad Parvez Sheikh, Managing Director, Vice Chancellor BUITMS, and other senior officials were also present.

Honourable Governor approved the Master Plan and appreciated efforts made by NESPAK.

Construction Supervision Starts for Al-Suwaiq – Huwqayn/Al-Hazm Road in Sultanate of Oman

Ministry of Transport and Communications, Oman has awarded to NESPAK the construction supervision of 48 km road between Al-Suwaiq town and Huwqayn/Al-Hazm town.

The project started in September 2004 will be completed in a period of nine months. The cost of this project is Rs. 250 million.

Construction Starts at Bahla Wilayat Water Supply Scheme in Muscat

The Ministry of Housing, Electricity and Water, Sultanate of Oman had awarded NESPAK the design and construction supervision of Bahla Wilayat Water Supply Project. The scope of work includes water source study and preparation of tender documents. The design works have been completed whereas the construction is in progress.

Al-Sagheer Consultants Awards Highway Project to NESPAK in Kingdom of Saudi Arabia

M/s Al-Sagheer Consultants has engaged the services of NESPAK for the design of 325 km farm roads in various areas of eastern region of Saudi Arabia. The Client is Ministry of Communications (Kingdom of Saudi Arabia).

The scope of works involves topographic survey, geotechnical investigation, hydrological studies, pavement design, geometric design and preparation of tender documents.

Geotechnical Studies Conducted for Istalif Hydropower Project in Afghanistan

NESPAK has been awarded the task of performing geotechnical investigations for Istalif Hydropower Project in Afghanistan by M/s KOWACO of South Korea. The field work has been successfully completed and laboratory testing and evaluations are in progress. The total project fees is US $ 32,000/-.

Design for Kabul University Approved

NESPAK has been engaged by the Government of Pakistan as consultants on Health and Education Projects in Afghanistan. Preliminary design of Allama Iqbal Faculty of Arts at Kabul has been submitted and it comprises teaching block with a covered area of 150,000 sft. Which has been approved by MoHE for detailed designing.

NESPAK Remained Active in Upgrading and Rehabilitation of Sewage Treatment Plants and Sewerage Systems in Five Towns of Sultanate of Oman

Ministry of Regional Municipalities, Environment and Water Resources, Muscat had awarded consultancy services for "Upgrading and Rehabilitation of Sewage Treatment Plants and Sewerage System at Khasab, Buraimi, Nizwa, Sur and Misfat Al-Abreen" to NESPAK.

The scope of services under the project includes preparation of detailed design, tender documents and construction supervision. The work on this project is in progress.

NESPAK Awarded Infrastructure Development Job in Dominica

Structural Engineering Division has won a project in Dominica. This is the first time that NESPAK is carrying out a project in the Caribbean Islands. The project involves the design of new bridge and widening of existing bridge over river Roseau. A NESPAK team of structural, geotechnical and hydrology experts visited the project site to collect the basic data and information and to plan further investigations. The project is being funded by the Kuwait Development Fund.

NDC
Remodelling of Pat Feeder Canal System

The Irrigation and Power Department, Government of Balochistan, has signed an agreement with a joint venture of National Development Consultants (NDC), Lahore and Engineering Consultants International Limited (ECIL), Karachi to prepare a detailed design and provide engineering services including construction supervision for the remodelling of existing Pat Feeder Canal System.

A spokesman of NDC said here today that Pat Feeder System includes Kirthar, Uch and Minuthy Canals which are being remodelled. Costing Rs. 2 billion the Pat Feeder Canal Extension Project will be completed in three years.

After remodelling, the capacity of Pat Feeder Canal System will increase from 6700 cusecs to 8560 cusecs and bring under cultivation an additional area of 159,000 acres. This will bring prosperity to the people of the area besides employment to hundreds of unemployed.

Under the Indus Water Accord of 1991, Balochistan was allocated perennial share of 3.87 million acre feet (MAF) of water but due to limited capacity of Pat Feeder Canal System, only 3.05 MAF of perennial flow could be utilized.

Pat Feeder Canal Extension System Project envisages construction of 37 kilometer long Pat Feeder Canal extension downstream from the canal's present tail, distributary head-regulators, cross-drainage structures, flood inlet structures, distributaries, minors, bridges, fall structures, flood embankments and installation of telecommunication system.

Improving Baluchistan Canal System

The Sindh Government has launched a massive programme to revamp and rehabilitate its vast network of irrigation and drainage system in the province at a cost of Rs. 12 billion. The Project will take four years to complete.

To execute the project, the Sindh Irrigation and Power Department has awarded a contract to a consortium of three leading firms of Consulting Engineers led by the National Development Consultants (NDC) for providing engineering services and construction supervision of a large network of irrigation and drainage system in the province which has gradually deteriorated due to delayed maintenance.

The agreement was signed the other day by Mr. Bashir Ahmed Dahar, Secretary, Irrigation and Power Department, Government of Sindh and Ch. Ghulam Hussain, Managing Partner of National Development Consultants, the lead firm ; Mr. Akhlaq Ahmed of Engineering Consultants International (Pvt.) Limited and Mr. Muzammal Qureshi of Engineering Associates, Karachi.

The irrigation system of Sindh comprises seven canals off-taking from Sukkur Barrage, four canals off-taking from Kotri Barrage and three canals off-taking from Guddu Barrage. Total length of these canals is 18,500 kilometers. Other related infrastructure consists of barrages, canal falls, regulators and cross-regulators, super passages, siphons and aqueducts etc.

The infrastructure of this irrigation system has deteriorated over the years from frequent breaches, wear and tear at canal banks and clogging of irrigation channels with sediment and debris.

In an interview, Ch. Ghulam Hussain, CEO of NDC, said here today that the responsibilities of the Consultants include planning and design, procurement, implementation and detailed construction supervision of the Project. Other engineering services include repair and replacement of regulators gates ; replacement of road bridges ; repair of modules ; revamping of telecommunication system on canal networks ; rehabilitation and replacement of tube wells and pumping stations ; repair of water courses ; bed clearance and strengthening of the drains.

On completion of the Project after four years, the renovated irrigation and drainage system will be able to operate for a long period to achieve their envisaged objectives, he said. The wastage of water will substantially be reduced ; more land will be reclaimed from water logging ; new areas will come under irrigation ; yield of crops will increase ; socio-economic conditions of farmers will improve with relative increase in GDP besides opening new opportunities of employment, the NDC Chief added.

A team of experienced engineers led by Engr. Mohammad Idris Rajput, a former Secretary Irrigation and Power Department, Sindh has been approved by the Government of Sindh to carry out this gigantic assignment, he concluded.

WELCOME TO NEW MEMBERS

The Executive Council of the Pakistan Engineering Congress approved Membership of the following new members in to the Congress fold. The Engineering News congratulates all of them and welcomes to PEC

Members admitted on 6-11-2004

1 Engr. Muhammad Abdul Latif
2 Engr. Muhammad Arshad
3 Engr. Noman Zafar Ch.
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10 Engr. Fareeha Mahmudi
11 Engr. Ch. Muhammad Ali

HIGH ELECTRICITY RATES, CAUSES AND PROSPECTS OF REDUCTION

By

Saeed Akhtar Niazi*

Abstract

Good were the days when electricity was cheap and affordable. From paisas 12 in 1970, it has risen to an average of Rs 4 in 2003. Fantastic! High electricity rates have rendered the electricity beyond common man's reach. The industry is getting strangulated to an extent that it is either opting for captive generation or running out of business. Agriculture sector suffers no less, with consequential rise in the price of agriculture products. Discussed below are some, if not all the causes that have contributed towards this abnormal rise with suggestions to reduce.

System Losses : Pilferage/Theft

Whenever one talks of the high electricity tariff, the thought that immediately comes to mind is the colossal wastage of energy in system losses. This, for most of the people means pilferage / theft of electricity and in the opinion of the majority, the only cause for the ever-increasing rates of electricity. This thinking is not only confined to the electricity consumers with limited educational background but the enlightened elite as well.

The energy losses due to theft/pilferage of electricity in Pakistan, particularly in KESC system, are no doubt a menace, eradication of which must be given high priority. All the successive management have been trying to reduce the pilferage losses but with limited success. Last management in WAPDA had undertaken massive and unprecedented efforts to root out such losses. Whether they succeeded in arresting pilferage and to what extent is anybody's guess. But statistics do not reveal any reduction. Perhaps, the pilferage losses decreased somewhat but not significantly. On the contrary, there has been some increase in the total losses probably because of neglect of technical up-gradation both in transmission and distribution sectors. It only shows that pilferage losses are not entirely in utility's hands. Such losses are in fact due to economic, social/cultural and law & order reasons. More expensive the electricity, higher is the incentive for theft. The attitude of the consumers is such that they do not consider pilferage of electricity as theft. Moreover, there are 'no go' areas all over the country from FATA down to Karachi.

Some suggestions that might help in reducing pilferage in the short and the long run are:

i) WAPDA must continue with its administrative efforts to reducing the incidence of theft with ever-increasing vigour. Some functionaries may be conniving. Appropriate action, not necessarily punitive, is required. Perhaps, indoctrination coupled with motivating incentives may prove useful. However, in so doing, it should remain cost/effort affective.

ii) Economic reasons: All possible efforts should be made to mitigate the impact of the various factors on the tariff. With cheaper electricity, there will be less incentive for theft.

iii) Social/cultural reasons: WAPDA and the government with the help of intellectuals, Pesh- Imams, ulemas and educationists think out ways and means to inculcate the culture of making people realize that pilferage of electricity is 'theft.' Suitable additions in the textbooks may help bringing about wide awareness.

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* Former Member (Power) WAPDA.

iv) Law and order: This issue is directly related to the government. Improved law and order situation shall have a very positive impact in reducing theft.

Technical Losses:

These include

a) Consumption in power plant auxiliaries
b) Transmission and transformation losses
c) Distribution losses.

a) Consumption in auxiliaries is a genuine use of power, required for the running of the power station and may not be termed as loss. Never the less, a watchful eye is necessary to avoid some obvious administrative and technical omissions.

b) Transmission and Transformation losses

This is the energy lost in transmission through primary and secondary transmission lines spread far and wide in the country. Likewise, some energy is lost in transformation and a small amount in the grid station auxiliaries. The loss in transmission and transformation is unavoidable to a certain extent. There are, however, strong reasons to believe that WAPDA has not been very zealous in containing technical losses in transmission system both primary and secondary. On the primary side, major 500kV connection of Ghazi Brotha to the system is still under construction. It is also reported that 500 kV line between Muzzafar Gharh and Gatti has not yet been completed.

On the secondary side, 5th Secondary Transmission & Grid (STG) project is believed to be incomplete 4 years after due date. In certain cases, it has since become redundant. Such omissions are likely to increase losses apart from creating system constraints.

c) Distribution Losses

A considerable energy is lost in the delivery of the electricity to consumer's premises in 11 kV & 400 V lines. It may have more serious consequences if not attended to in time. With increasing load coming onto the old and inadequate distribution network, the technical losses are on the increase. Moreover, the system suffers from frequent interruptions. There is hardly any evidence of any significant Renovation or Energy Loss Reduction program to improve or cater for any future increase.

According to a NEPRA presentation, pilferage losses are about 4% of the gross energy causing a loss of revenue of Rs. 8 billion. It is an estimate and could be little more. The fact remains that bulk of the losses are technical and deserve to be given due priority. It would require considerable financial and human resources spread over a period of time to bring the losses down to a reasonable level.

WAPDA must continue its efforts to control the menace of pilferage of electricity but it may not allow a smoke screen to be created that might camouflage some equally important component of losses that ultimately lead to increase in tariff. Control of technical losses should get no less attention. It may also be borne in mind that quality of service is deeply intertwined with actions required for reduction of technical losses.

Hydle-Thermal Mix

There was a time when WAPDA had a high component of cheap hydel power. The energy mix in the power system used to be around 73 hydel to 27 thermal in 1962. The ratio diminished over the years till in year 2001, it almost reversed with 29 hydel to 71 thermal. Other factors notwithstanding, the average sale price of electricity per kWh, that remained steady at around Ps. 12 till 1970 started rising. In 1978, it was Ps. 29. It went up only to Ps.165 in 1995 including self-financing of future power development projects to well above 40% of the Public Sector Department Programme (PSDP) and payment of hydel profit, 10 % of total revenue. The present average price is Rs.4, with only 2.5% as hydel profit and a very small percentage of self-financing (if any). The history of hydroelectric development in post partition Pakistan started with Dargai, Rasul, Chichoki, Shadiwal and got a major thrust forward by the construction of

Warsak. It was quickly followed by large storage hydel projects namely, Mangla and Terbela. Kalabagh, although a serious competitor to Terbela was deferred till after the completion of Terbela for some valid reasons. However, it failed to take a start even after completion of Terbela. Later, in 1985, when its design and tender documents were ready, it became a victim of an unfortunate environmental turned political controversy. Because of the failure to maintain thrust on hydroelectric development and extraordinary delay in the construction of a reservoir-based power station, the system of necessity moved towards thermal power, mostly using imported furnace oil, cost of which increased continuously with increasing value of dollar. This further dovetailed into yet more expensive thermal IPPs resulting in a mix of around 29 hydel to 71 thermal in 2001. Nation's inability to build a reservoir project in continuation of Terbela is obviously the biggest single factor for the electricity tariff increase.

The small/medium size hydroelectric projects with only peaking poundage would not take us very far. A quantum jump would be necessary to put on rails, the derailed hydroelectric development in the country. 'Kalabagh plus Munda', Basha, Dasu etc must come in quick succession in order to keep power rates in check.

GOP must develop consensus for building large reservoir hydroelectric project at the earliest. Reservoir projects are, as a matter of fact, more important for those who complain of water shortage. Critics of the storages may kindly note that there are other options for electric power perhaps more expensive but there is no substitute for water.

IPPs

Independent Power Producers (IPPs) added a big chunk of power in WAPDA's power system but unfortunately, the demand ceased to grow and did not keep pace with load forecasts. This resulted in excess power situation in WAPDA system. Permission to allow captive power to the Industry further aggravated the problem. WAPDA has been caught in a situation where it has to make large capacity payments irrespective of its actual usage. WAPDA reportedly, considers itself incapable of finding a solution to it and has reconciled to the situation. It is waiting for better times when the heavy up front payments are over and capacity payments reduce. Low utilization of IPPs is significantly accentuating the already high rate of the power purchased from IPPs. This is a very big burden on WAPDA finances and needs innovative approaches to reduce the burden. Every problem has a solution. No doubt, this has too. Take steps to stimulate load growth in a manner that peak load remains in check.

Economic Forces/Dollar-Rs. Parity

International economic forces have had significant reflections on Pakistan's economy. In particular, Pak. Rupee devaluation has badly impacted the electricity rates. Since major portion of the cost of power projects has, of necessity, to be in foreign exchange, the project costs kept on increasing with almost continuous depreciation of rupee. Due to failure to promote self-reliance even in conventional technologies like hydroelectric plant manufacture, our import bill continued to increase. Major part of IPP payments is also dollar related. Until 1970, the official $-Rs parity was 4.75 rising to Rs11/10 in 1972. In 1990, the dollar was Rs.22 increasing to Rs.30 in 1994 and skyrocketing to over Rs. 66 in 1999 or so, however sliding, to 58 in 2003. By way of illustration, if the dollar comes down to Rs. 50, the saving to WAPDA because of capacity costs and debt repayments alone would come to about RS. 16 billion.

The dollar- rupee parity is a macro level issue and the electricity consumers will have to bear with it unless the GOP can come out with a solution.

Furnace oil price

Oil was Rs.2300 per ton in mid 1990's. Now it is Rs. 12000. Impact is obvious both for WAPDA and IPPs. This contains a sizeable component of taxes and duties. Ever- increasing value of dollar and international oil market trends directly impact the oil prices. In other words, high oil prices are the result of national and international economic forces and the electricity consumers have to reconcile with this.

Sooner we switch over to gas, wherever possible, the better. WAPDA seems to have converted to gas. Apparently, IPPs seem indifferent perhaps because they get fuel costs as

pass through. In such a situation WAPDA ought to play pro-active role, being the ultimate sufferer.

Outstanding dues

Money has value particularly for the two utilities that are still charged a high interest rate on GOP loans. For public sector dues, GOP's help is necessary as was done in mid 1990's. One reason put forward by the organizations is that they lack adequate budget allocations.

Government must ensure adequate allocations for its own formations, the provincial governments and the local bodies to enable them to pay their bills.

FATA

In the private sector, FATA recoveries are beyond WAPDA. Only GOP can find a solution. If, even the government cannot resolve, it should pay itself through other sources as a clear and announced subsidy to the tribal areas. There is hardly any justification of passing the burden on to the corporatized utilities and its consumers.

Duties and taxes

There are several duties and taxes imposed by the government at various levels and stages e.g. in the development of the power system, production of electricity and its sale. GOP has full right to impose any duty or tax it deems appropriate in the overall national interest. However, from the information available, it transpires that GST is being charged on the sale of power by the IPPS to the utilities as a pass through item. Utilities are again charging GST on the sale of electricity to the consumers. In other words, the consumer is being taxed twice on the same account. The amount of GST charged for the sale of electricity by IPPS to WAPDA is about 7 billion. This does not appear justifiable. There is another tax/duty known as electricity duty, imposed by the provincial governments. This duty was reportedly levied by the West Pakistan government through legislation for undertaking power-related activities, which over a period of time became exclusive responsibility of the Utilities. This duty may either be abolished or the money thus collected be placed at the disposal of the utilities for development activities like rural electrification etc. The amount for WAPDA is reported to be about 1.7 billion. The issue requires expert legal opinion.

Economic Load Dispatch

Economic load dispatch can bring about a lot of savings in financial terms National Power Center (NPCC) has charted out an economic dispatch order and is renewed periodically. However, there is evidence to believe that transmission and transformation constraints prevent this. There is an urgent need to pay attention to this aspect. There is also need to re-examine the economic order at expert level. Definition of 'economic dispatch' is prepared solely by WAPDA. Consultation with other power generators is considered essential to ensure level playing field.

There has been on the anvil a project known as 'Upgradation of NPCC' for a long time. Early completion should significantly help.

WAPDA Surplus of power, KESC Short of Power

Excess power in the wake of IPP additions has already been discussed above. Ironically, Karachi is suffering due to shortage of electricity while WAPDA is grueling under the burden of excess electricity. KESC is being supplied by WAPDA 400 MW and perhaps more at peak. It has a pending load of 250 MW, which continues to grow. WAPDA on its part is bearing the burden of paying a large sum of about RS.60 billion to IPPs as capacity charge. A substantial portion of this capacity payment goes waste as IPPs are underutilized. Reported loss of Rs. 8 billion due to theft, sinks into insignificance when compared to this. WAPDA may therefore, give special attention to control this excess, in proportion to the damage it is causing. WAPDA hitherto considers this as unavoidable. Improved utilization of IPPS will provide a big

financial relief for WAPDA. On its part WAPDA appears to have following reasons for its inability to do so.

i) Lack of load growth. According to credible load forecasts carried out in 1993-94, load on system was expected to grow at the rate of 8 %per annum. In actual fact, it came to a halt in 1996. Growth remained 3-5% in the years thereafter with only some recent signs of its picking up. Promotion of load growth is not entirely in Wapda's control although neglect of rural electrification and some other signals suggest suppression of load growth. Nevertheless, WAPDA can take many steps to stimulate load growth by sending appropriate signals through tariff as well as taking measures to promote sales. Also there are customers who complain of refusal to get connection from WAPDA on the plea that their formations have been allotted a certain number that they could electrify in a year and that the others must wait. Like wise, there are customers who complain of delays of over 3 months since the deposit of the money, and are still waiting. Such complaints are no doubt subject to verification. If it is confirmed as such, WAPDA may like to suitably change its policy to encourage growth rather than discourage it. There are also reports of load shedding purportedly due to system constraints.

ii) System constraints It appears that WAPDA, for whatever reasons, has not been able to develop the transmission and distribution system to match the demand growth. This prevents proper dispersal of power and economic dispatch. According to 2002 annual report, WAPDA Power Private Sector Organization (WPPSO) and Transmission and Grid (T & G) deign were still debating the dispersal arrangements of IPPs. Earliest possible completion of such arrangements should greatly help increased flow of power, reduce losses as well as improve reliability.

iii) Inadequate/unsatisfactory arrangement to feed Karachi This is the most important single factor that can enhance system load. A 500/220kv link between HUBCO and KESC will enhance load on WAPDA system making IPP input somewhat cheap. It will greatly enhance reliability of supply in KESC area of franchise. The present mode of transmission is not only inadequate but also unsatisfactory. It will relieve Wapda 220 network to Karachi for providing much needed power to Nooriabad etc. 500/220kv direct link project has been on the anvil for a long time and is now believed to be on its way to construction. Urgency of the project and the relief that it is likely to bring about cannot brook any delay. An ingenious approach may be required to complete the project in the shortest time. Who knows, WAPDA own demand may rebound to an extent that any significant export may not be possible and the interconnection project may not remain as useful for sometime. Maxim that time waits for none is truer now, in a highly dynamic world, than any time before.

iv) Slowdown of village/rural electrification tempo Village electrification appears to have slowed down considerably over the past many years. Although rural domestic connections do not add to the load growth as much as same number of urban connections, yet rural electrification provides opportunity for tube wells and small agro based industry. It greatly helps in alleviation of poverty. Low level of rural electrification has therefore, contributed to low overall load growth of the system. Ironically, when there was shortage of electricity, more and more villages were electrified and ever since, system started having excess electricity, less and less villages are being electrified. Government provides ADP allocation for rural electrification. Statistics show considerably reduced electrification, down to about 1500 villages for the last many years from over 6200 in mid 1990's (There is evidence of tempo building up in the recent past). Government may consider reviving the tempo of the rural electrification at least to its previous levels. This would require the GOP quadrupling its ADP allocations if load growth is to be picked up. Government must meet its social obligations and also mitigate poverty. Load growth thus achieved will help lowering the electricity rates.

Demand Side Management (DSM)

WAPDA over the years does not seem to have made any significant effort towards demand side management, which is a very important function of any utility operations. It may be noted that no utility worth the name can claim to have optimized its economic operation unless it continuously follows a well thought out load management program. In simple terms, from utility's point of view, it means that the utility manages to deliver maximum energy in a given minimum installed capacity. The daily and seasonal load curves ought to be as flat as possible with system peaks chopped off. Such a system will save significantly in generation and transmission investment costs, proportionate to its efforts and shall therefore have minimum Long Run

Marginal Costs (LRMC). Additionally, for system like Pakistan, there will be significant reduction in T&D losses with less current flowing through the system during evening peak hours.

A conventional approach for demand side management is to resort to Time of Day (TOD) metering. Wapda is believed to have embarked upon such an approach in industrial sector where number of such meters required is small. Any attempt to introduce TOD meters in domestic sector would be highly expensive and it would take years before it could be implemented and benefits harvested. Luckily, in Pakistan scenario, relatively small investment can bring about large dividends. For instance, if 15 million consumers in the country are persuaded to use one energy saver bulb each, the system shall require 1200 MW of less generating capacity and corresponding transmission. In other word, the cost of installing a power plant of size of HUBCO and allied 500 kV transmission facilities would be saved. In other words, the country shall manage to cope with the demand for a further period of two years beyond the current load projections. In the immediate term, it shall open vistas of providing much needed relief to the consumers by reducing their electricity consumption and thus the bill. Ideally, the utility should take measures to improve the awareness of the consumers regarding the benefits that would accrue to them by adopting this load management measure. But a positive response from the consumers, particularly, those in the lower brackets, is unlikely firstly, because of lack of educational background and secondly, the high initial cost of energy saver bulbs. The prudent approach therefore, would be for the utility to induce the consumers by initially providing a suitable number of energy saver bulbs free of cost, so that they can see the benefits for themselves. To the affluent category customers, the utility may supply bulb against payment through the bill. This step will over a period, help reducing the tariff significantly apart from reducing the customer's electricity bill immediately.

The above prescription applies to KESC also. Advantage for KESC, however, will be more. Its system has a big power shortage. Hub-Karachi direct link should have provided the necessary relief to both WAPDA and KESC. The former would have mitigated its huge surplus and the latter in reducing its shortage. The completion of the link would take time. KESC can in the meantime reduce its peak requirement by resorting to energy saver bulbs. Roughly, use of 1.2 million energy savers of 20W displacing conventional 100 W bulbs at a cost of approximately Rs 170 million can reduce the system peak by 100 MW. In other words, 300MW of evening peak can be chopped off with an investment of RS 0.5 billion.

Miscellaneous

Other measures that could help reduce tariff are given hereunder.

Load shedding.

WAPDA must banish load shedding by eliminating system constraints and earn more revenue within the already available energy. It is a pity that nation continues to experience load shedding despite excess power availability. If in due course, a stage is reached that the peak demand outstrips the available power, the situation should be managed through demand side management as described above.

Integrated operation of WAPDA and KESC

Such operation will bring about many benefits. It will minimize generation expansion investment costs of both the utilities, bring about stability and reliability of service and also take advantage of staggered peak. A joint generation maintenance program shall optimize the generating capability. This will reduce outages inherent with disjointed and manual operation. WAPDA and KESC should have a joint packaged generation expansion program

Least cost plan

WAPDA and PPIB should not lose sight of least cost development plans for power generation expansion, credible studies of which were carried out by WAPDA. Projects other than in the least cost sequence should only be undertaken if these could be proved to be superior. Developing countries like Pakistan with scarce financial resources can ill afford such a luxury. This is applicable to both hydel and thermal candidates. ■

AN INTRODUCTION TO SUB-SURFACE (GROUNDWATER) DAMS

By

Mian Iftikhar Ahmad*

Introduction

In arid and semi-arid areas of the world, sand and gravel deposits associated with streams and rivers can provide water for drinking purposes as well as for irrigation. Such watercourses are generally seasonal, but can be perennial. Riverbeds which are dry, but have green vegetation along their banks and bed, indicate that there must be a source of water in the vicinity, below bed level.

Groundwater dams are structures that intercept or obstruct the natural flow of groundwater and provide storage for water underground. They have been used in several parts of the world, notably India, Africa and Brazil. Their use is in areas where flows of groundwater vary considerably during the course of the year, from very high flows following rain to negligible flows during the dry season.

The basic principle of the groundwater dam is that instead of storing the water in surface reservoirs, water is stored underground. The main advantages of water storage in groundwater dams is that evaporation losses are much less for water stored underground. Further, risk of contamination of the stored water from the surface is reduced because as parasites cannot breed in underground water. The problem of submergence of land which is normally associated with surface dams is not present with sub-surface dams.

Types of Groundwater Dams

There are two main types of groundwater dam: the sub-surface dam and the sand storage dam.

Sub-Surface Dams

A sub-surface dam intercepts or obstructs the flow of an aquifer and reduces the variation of the level of the groundwater table upstream of the dam. It is built entirely under the ground (Figure1).

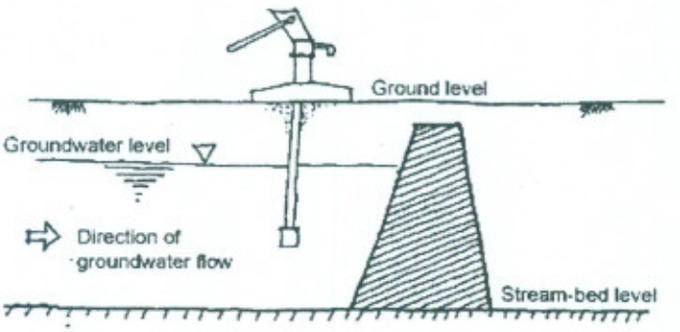


Figure-1: A sub-surface dam

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There are many advantages in the use of sub-surface dams compared to surface dams; these include:

(a) Losses from evaporation are very much less than the 2.0 metres lost annually from a free water surface in a dry tropical area.

(b) The breeding of insects (mosquitoes) and parasites is prevented.

(c) Contamination of stored water, by people and animals, is greatly reduced, particularly as a well or a hand pump can be provided to abstract water in a hygienic and controlled manner.

Sand Storage Dam

The sand storage dam is constructed above ground. Sand and soil particles transported during periods of high flow are allowed to deposit behind the dam, and water is stored in these soil deposits (Figure-2). The sand storage dam is constructed in layers to allow sand to be deposited and finer material be washed downstream (Figure 3).

The final height of the dam is governed by the bank height at its extremities and, in any case, should not be greater than about 5 metres. It should be constructed preferably of concrete or masonry, because its upper surface acts as an overflow weir and has to resist the erosive action of water which is laden with silt and sand in suspension.

The coarser the sand and gravel collected by the dam, the greater the size of voids and, therefore, the potential storage capacity. Gravels and coarser sands can store up to 35% of their total volume as water.

A groundwater dam can also be a combination of these two types. When constructing a sub-surface dam in a river bed, one can increase the storage volume by letting the dam wall rise over the surface, thus causing additional accumulation of sediments. Similarly, when a sand-storage dam is constructed it is necessary to excavate a trench in the sand bed in order to reach bedrock, which can be used to create a sub-surface dam too.

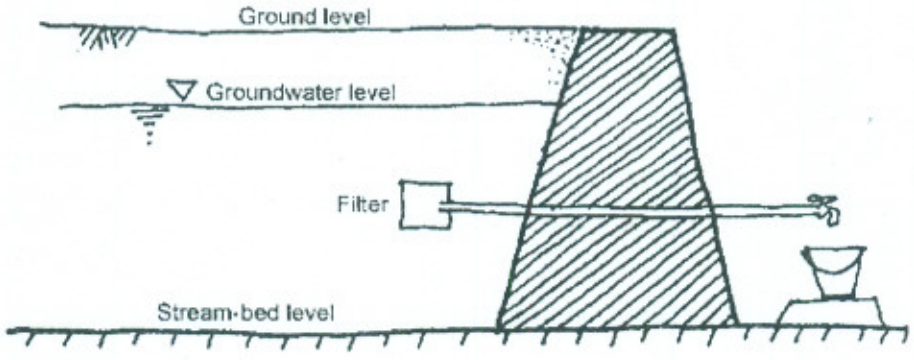


Figure-2: A sand storage dam

Groundwater dams are built across streams or valleys. A trench is dug across the valley or stream, reaching the bedrock or other stable layer like clay. An impervious wall is constructed in the trench, which is then refilled with the excavated material.

Various materials may be used for the construction of groundwater dams. Materials should be waterproof, and the dam should be strong enough to withstand the imposed soil and water loads. Dams may vary from 2 to 10 meters high. Materials include compacted clay, concrete, stones and clay, masonry wall or plastic sheets.

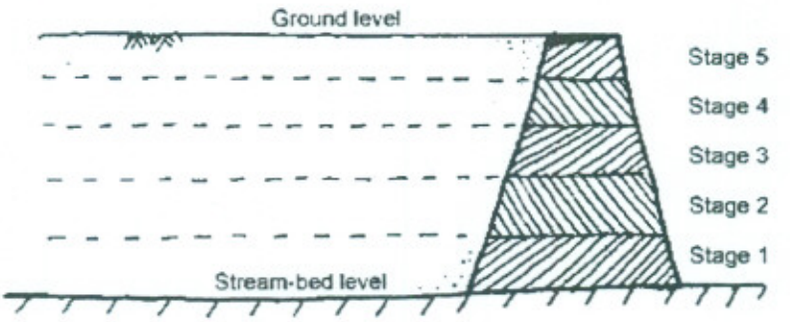


Figure-3: Stages of construction of a sand-storage dam

The reservoir is recharged during the monsoon period and the stored water can be used during the dry season. Excess water flows over the top of the dam to replenish aquifers downstream. Water may be obtained from the underground reservoir either from a well upstream of the dam or from a pipe, passing through the dam, and leading to a collection point downstream (Figures 1 and 2). Groundwater dams cannot be a universally applicable as these require specific conditions for functioning. The best sites for construction of groundwater dams are where the soil consists of sands and gravel, with rock or a permeable layer at a depth of a few metres. Ideally the dam should be built where rainwater from a large catchment area flows through a narrow passage. ■

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EFFECTS OF PD ON INSULATION OF 11 KV CABLES AND TESTING OF SPECIMENS

By

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ABSTRACT

The progress in recognition of Partial Discharge (PD) and their correlation with the kind of defect is becoming increasingly important in the quality control of insulation system. As the PD test at the PD inception level is non-destructive, it both may be used for type testing and routine testing. The type test shows the proper construction of the insulating system and the selection of adequate materials. The routine test proves the precise manufacturing of any piece which with some restriction may also be done by sampling test objectives. The measurement of PD has been applied to High Voltage (HV) cables. When we apply an a.c. voltage from initial conditions with no charge in and on the walls of the cavity, we can predict the electric field in the cavity as a function of time. The electric field within a regularly shaped cavity will be nearly uniform and will vary in proportion to the voltage between the electrodes. If the voltage between the electrodes is raised to the point that the field within the cavity goes above the breakdown field for the gas with in the cavity, a discharge (PD) can take place. It will not necessarily take place as soon as the voltage goes above the minimum breakdown voltage for the reasons described above. The time one must wait for breakdown depends very strongly on the voltage and on the Cavity size. [1]

1. Introduction

The most widely used insulation, polyethylene, is selected for the present work due to its advantages. It is not possible to get polyethylene specimens which are free from voids and inclusion because manufacturing processes frequently introduce dust particles imperfections, voids and sharp conducting occlusions at random sites within dielectric materials. All these unwanted particles will alter our experimental results. So polyethylene specimens are carefully prepared in a clean environment so as to free from voids and other particles. After the preparation of required specimens partial discharge detection tests were performed by applying voltage (ranging from 01KV to 20KV) to specified specimens from specified time (depending upon the facilities available at the laboratory). The required data thus obtained to correlate the magnitude of Partial discharge with the damage / degradation (in Micron) of the insulation in order to investigate the integrity of the insulation. [1,2,3]

2. Electrical Discharge Detection Methods

2.1 Principles

Apart from indirect method for partial discharge detection as e.g. optical, acoustical or chemical methods, the pure electrical detection technique as defined in the IEC standard, publication 271 [4] is in wide spread use. The main tasks of the test circuit are to apply the test voltages across the test object to suppress at least to some extent electrical noise and to ensure a high sensitivity for the detection of PC current pulses, which are excited by the partial discharge within the test object. There can be an inherent interaction between the impedance of the measuring system and the test circuit. The shape of the current pulses become very complicated if the size of either the HV test circuit or object is compatible to the wavelength of signals considered as e.g, with transformers or cables.

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For such situations it is extremely difficult or even impossible to forecast or to measure the shape of the actual PD current pulses, as these currents are superimposed on all the other test circuit currents excited by the test voltage (including its harmonics) and by other noise sources. The objective of PD measurement is to perform measurement of the current pulses produced in the measuring circuit as a consequence of ones occuring inside the discharging void by using a detection system of adequate sensitivity [3]. At preset most of the present state of the art of PD measurement and interpretation rests on detecting PC signals, external discharge pluses and associated energy i.e. the two basic quantities.

Although direct detection of such very short duration current pulses is usually not performed in practical applications, such measurements can supply important information concerning the nature of the fault and the related discharge processes. A high degree of experience in interpreting the measured data is required.

2.2 The Measuring Circuit

The PD measuring circuit is defined as a sub-part of the PD test circuit, the main components of which are the test object and a coupling capacitor. The measuring circuit is defined in a somewhat simplified way by "the measuring impedance Zm, the connecting leads and the measuring instrument" through it would be more convenient to call this circuit a measuring system, as these three components may strongly interact with each other and highly sophisticated electronic circuits may be involved.

Partial discharges in the test object cause charge transfer in the test circuit, giving rise to current pulses through the measuring impedance and by this the measuring impedance is definitely meant to be the input end of the PD measuring systems and the input quantity is a current pulse, all further explanation are based on voltage pulse [3]. Discharges cause patterns of current impulses in the lead of a sample. A variety of circuits are in use to detect these impulses, but they can be reduced to one basic diagram [1]. The elements are as follows.

1. A high-voltage source, preferably free from discharges.
2. A sample.
3. An impedance Z, across which voltage impulses are caused by he discharge impulses in the sample.
4. A coupling capacitor k, which facilitates the passage of the high-frequency current impulses, and must be of the same order of magnitude as the sample.
5. An amplifier A.
6. An observation unit O, which be a crest voltmeter, an oscilloscope, a pulse-sampling device [2].

The signals from the coupling impedance are filtered to remove any power frequency components. The characteristics of the filter which should also include consideration of other system components such as amplifier are such that the current pulse signals are integrated to yield a pulse magnitude, which is proportional to the charge in the PD pulse. The integrated pulses are normally displayed on an oscilloscope so that the magnitude and phase position of the PD pulses can be displayed vs the voltage.

2.3 The Detection Impedance

The impedance Z can be connected to the sample in two different ways. It can be placed in series with the sample or placed in series with the coupling capacitor. The HV test arrangement for PD measurement is defined in the standards. IEC 270 or IEEE 454 –1973. Both methods generate current by the PD activity in the test object. The current results in a voltage drop on the measuring impedance and by a filter following the impedance with which the integration of the current proportional voltage is approximated. The same voltage occurs across the impedance Z, assuming that the impedance of the H.V source is large. However, in practice,

the connection of Z may be important. For instance, if the sample is large, Z is often placed in series with K so that the large charging current does not pass through the impedance Z [2].

Two impedance commonly used are a resistor R shunted by a capacitor C, or an oscillatory circuit LCR. The voltage impulses, which occur across these impedance, have been calculated with the aid of transformation.

2.4 The RC Circuit

In the RC circuit [2] the impulse appears to be unidirectional. The impulse can be calculated to be:

$$V = q/ (a+c (l + a / k) \exp (-1/ R_m)) \quad (1)$$

Where a, k and c are capacitances and q is the magnitude of the discharge causing the impulse, Furthermore,

$$m = (ak / (a + k)) + c \quad (2)$$

2.5 The LCR Circuit

In case of the oscillatory [2] LCR circuit, the impulse is an attenuated oscillation with the same crest voltage as with RC circuit.

$$V = q / (a + c (1 + a / k)) \exp (-1/ 2 R_m2) \text{ Cos } \omega t \quad (3)$$

where m has the same value as in Eq 2.

2.6 Conclusions

Some important conciusions can now be drawn.

1. It follows from Equation (1) to (3) that height of the impulse is proportional to the magnitude q of the discharges. Methods using this circuit enable us to measure the discharge magnitude.

2. It follows further that the height of the impulse is independent of R. However, if R is small the time constant is small and thus, the impulse is sharp. This sharp impulse will not be amplified fully in some amplifiers and the resulting impulse as shown, for instance, on an oscilloscope, becomes smaller if r is decreased.

   A good discharge detector has therefore variable impedance that can be matched to the sample capacity; usually this matching is realized in five of six steps.

3. It also follows that a coupling capacitance K is needed as, otherwise, C/K in the denominator is too large and the impulse become too small. In some cases a separate capacitance for K is not provided and K is equal to the arbitrary capacitance of the HV source. It is clear from the above discussions that this may lead to unsatisfactory results.

3. Noise Sources

There are three sources of noise that may conceal a discharge impulse.

1. That from the amplifier.
2. That from the circuit and
3. External interference.

The principal limitation to PD sensitivity is caused by thermal noise in amplifiers and resistors. This is disadvantageous as the sensitivit, then deteriorates linearly with the sample capacity.

The noise of the detection circuit can be brought up to the level of that of the amplifier by stepping up the signals with a transformer. The sensitivity can be improved appreciably in this way. Comparison of the increase in detected PD energy and thermal noise energy, as the detection band width, indicates that the PD signal to amplifier noise ratio improves as detection bandwidth increases [2].

When PD tests are done in the field, for example in substations or generating stations external electrical interference is usually the predominate source of noise. External noise source include corona or PD from the HV supply, thruster switching interference, and arcing from slip ring brushes or arc welding. All these noise sources can produce current pulses which can have many characteristics in common with test piece PD, such as frequency content, ac phase position, repetition rate etc. (Radio Frequency signals from radio transmitters or power line carrier transmission are of less importance since they can be easily filtered out) such noise pulses can be misidentified as legitimate PD pulses which can lead to HV equipment incorrectly being identified as defective.

This interference can be minimized to some extent by installing the whole setup of the experiment in a faraday's cage.

4. Resolution

Discharges occur only in two quadrants of the 50 or 60 HZ sine wave. If several discharge sites are present, the discharges occur at random in these quadrants, and the time intervals between the successive impulses are scattered in a statistical way. In order to obtain a clear trace of the discharge impulses on oscilloscope, the detector must be able to separate the greater part of the impulses. If the impulses are insufficiently separated, a hazy luminous trace appears on the screen. Alternatively, the impulses are superimposed so that an incorrect reading of the discharge magnitude is obtained.

According to Mole, the degree to which the impulses can be separated is given by the resolution which is defined as the number of impulses that can be distinguished in one quadrant of a 50 c/s sine wave, assuming that the impulses are separated by equal time intervals.

The resolution depends on:-

1. The resolution of the Oscilloscope Screen.
2. The resolution of the detection circuit.
3. The resolution of the amplifier.

The resolution of a discharge detector is equal to the smallest value of Y, which is determined by the smallest of the following three values.

1. The optical resolution of the oscilloscope screen, this is usually about 250 impulses per quadrant.
2. The time constant T of the Signal.
3. The bandwidth B of the amplifier.

5. Observations

5.1 Oscilloscope

The classic, and still the best, way to observe the impulses of partial discharges is to display them on an oscilloscope. The discharge impulses are usually displayed at a time base of the same frequency as the applied test voltage. Current discharge in successive cycle cover each other and fairly stationary picture is obtained as shown in Fig. 1 (a). In order to relate the timing of the impulses to the phase angle of the test voltage the impulses are superimposed on to the sine wave of the test voltage as shown in Fig. 1 (b). This picture on an elliptical time base is even clearer in Fig. 1 (c). The ellipse is situated in such a way that top and bottom coincide with the zero crossings. In Fig. 1 (d) the time base has been made yet more characteristic by giving it sharp edges [2].



Fig. 1 (a)



Fig. 1 (b)

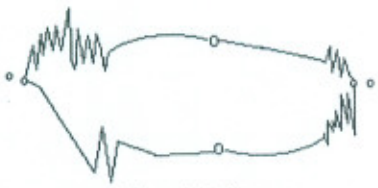


Fig. 1 (c)

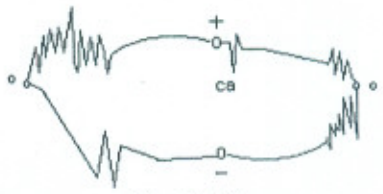


Fig. 1 (d)

Fig. 1 Display of Discharge impulses at 50 or 60 Hz

The discharge patterns in these ways give a good indication of the type of the source of the partial discharge [1].

CRO-display	Description	Type of discharge
Fig. 2	Impulses between zero transition and peak on both half waves. On the average, the impulses are of identical size on both half waves.	Cavities in solid insulators, gas bubbles in liquid insulators. Touching insulated conductors. Creeping discharge on surface without Mattel contact, floating metal parts.
Fig. 3	Impulses between zero transition and peak of both half waves. On the average, impulses of half wave are larger.	Cavities in insulator at electrodes. Large pulses in positive half waves: discharge on voltage side. Large pulse in negative half wave discharge on groundside.
Fig. 4	Impulses symmetrically arranged around both zero transitions.	Poor contact b/w metal parts or between semi conducting layers.

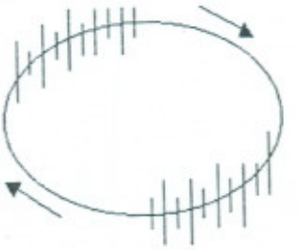


Fig. 2 Impulses between zero transition and peak

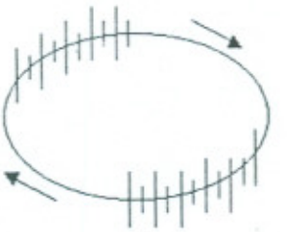


Fig. 3 Impulses between zero transition and peak

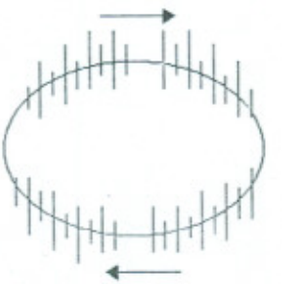


Fig. 4 Impulses symmetrically arranged

5.2 Discharge Magnitude

The discharge magnitude can be determined by adding a calibrating impulse to the time base. The height of the calibrating pulse is expressed in Pico coulombs and is compared to the size of the discharge impulses.

5.3 Peak Voltmeter

Observation by means of an oscilloscope may be too complicated for use in industrial tests. In this case, good use can be made of a Peak voltmeter. This reads the crest of the highest impulse, i.e. the magnitude of the largest discharge present. It is good practice to make a x-y diagram of the observed discharge vs. test voltage [1].

5.4 x-y Recorder

An x-y diagram can be plotted automatically with the aid x-y recorder. A signal from a voltage divider is fed to the x-axis and a logarithmic signal from the peak voltage-measuring device is fed to the y-axis. Care must be taken to see that all the discharge patterns on the oscilloscope are checked at the same time as otherwise nonexistent discharges, disturbances, noise signals, etc. could be recorded without it being known that the resulting is a fake.

5.5 Impulses Counter

An advanced method of observation is obtained by the use of impulse counters. The impulses are electronically classified according to their amplitude and count. In this way, diagrams are obtained which show the number of discharges per unit of times as a function of their magnitude [1]. Although this method of observation contains more information, it has the disadvantage that characteristics cannot be separated and are superimposed if more than one

discharge site is present. The method is used mainly for test set-ups containing well – defined discharge sites. Impulse contain is an excellent and almost indispensable method for discharge detection at DC voltage, where only a few discharges per minute, or even per hour, occur.

5.6 Data Processing

The information contained in the sequence of discharge impulses can be processed in many ways e.g. the development of microprocessor technology enabled experiments to design some digital instruments capable of measuring a wide range of PD parameters, and hence of taking into account many aspects of discharge activity related to failure time. A very large memory buffer is required in order to allow very large PD data to be collected in a very short time interval. Furthermore, the advent of macular pulse spectroscopy made multichannel pulse – height analyzers (MCA) commercially available at ever decreasing cost. Thus making PD analysis techniques based on measurement of both PD pulse charge and repetition rate is possible.

6. Actual Detection Circuits

HV test circuits for PD measurements can be used in practice in two different ways.
Straight detection.

Balanced (or Bridge) detection [2,3].

6.1 Straight Detection

In this method, an RLC detecting impedance is used in the grounding circuit of the coupling capacitor while the specimen is directly grounded. The RLC impedance (Zm) [1] is used as a transmission element between the detector and the coupling capacitor and transforms the very short PD pulse, superimposed on the power frequency current component into a decaying consign transient pulse having zero-time amplitude proportional to the charge fed into the specimen terminals (apparent charge) as a consequence of the charge flowing across the internal void (true charge). A straight detection circuit [5] is used for the detection of PD.

6.1.1 Characteristics

The characteristics that determine the performance of straight detection can be considered as:

1. The shape and the size of the impulses at the detection impedence give the response to a charge q. The height of the response is: -

$$V = q/ a + (1 + n)\, c\, n = a / k \qquad (4)$$

Where a, c and k are capacitances, q is the magnitude of discharge causing the impulse. V varies from a few millivolts at small samples downwards to a microvolt at a large sample of 1 μF.

2. The sensitivity, being the smallest detectable discharge, is given by (if circuit noise is matched to amplifier noise by a step up transformer).

$$q_{sense} = 4 \times 10^{-4} \times ((n + 1\xi) \times \sqrt{a + (l + n)\, c}) (Pc) \qquad (5)$$

Where n is the ratio between the samples and c is given in Pico farads.

3. The resolution is the number of discharges that can be resolved in on quadrant, it is determined by oscilloscope, detection impedance and amplifier. A reasonable figure is 250 impulses per quadrant, corresponding to 20 μs between two successive pulses.

6.2 Balanced Detection

In this case, PD signals are obtained as the difference between the voltages of two resistive impedances put in two distinct branches, one containing the specimen under test and the other a discharge free coupling capacitor having the same frequency dependence of dielectric losses as the specimen. In this case, the displacement current and its harmonics are suppressed by a common rejection mode of the bridge circuit and pulse signal integration is performed at the upper cutoff frequency of the pulse amplifier [3]. Discharge in the samples is detected as before but discharge pulses from outside the sample can be suppressed. This means that discharges in the coupling capacitor or the transformer are rejected and interference from the mains can be suppressed appreciably. A balanced detection circuit, which is known as Kreuger's bridge [1] is used for the detection of PD in noisy environment.

6.2.1 Characteristics

The characteristics of a balanced detector, apart from those relating to balancing are the same as those of a straight detector. The characteristics that determine the performance of balanced detectors are as follows.

1- The size and shape of the pulses, fed from the bridge points to the balancing transformer are given by:

$$V(t) = V \times e^{4/3} \qquad (6)$$

Where $V = q / a+c+(n+I)\ c$ and $T = R \times [a+c+(n+I)c]$

The relation is valid if the bridge is at balance in the same manner as with the straight detection. The response is given by:

$$V = q\ a \qquad (7)$$

2- The sensitivity of the sample is similar to that of straight circuits.

$$q_{sense} = 4 \times 10^{-4} \times ((n + 1\xi) \times \sqrt{a} + (I + n)\ c)\ (Pc) \qquad (8)$$

Where qsense is the smallest detectable discharge expressed in Pico coulombs (a discharge is assumed to be detectable if its height is twice the noise band from zero to top), n is the ratio between samples, capacitances are expressed in Pico farads.

3- The resolution of the balanced detector is expressed as the number of discharge impulses that can be resolved in one quadrant of the ellipse on the scope. This resolution r is determined in the same way as with straight detection.

Experiment has shown that a resolution of 25 to 50 impulses per quadrant is unsatisfactory and a resolution of 250 to 1000 is excellent, whereas high resolutions of 2500 or more may give only faint impulses of the oscilloscope screen. Resolution at too low a level leads to blurred pictures and unrecognizable discharge patterns and also to erroneous readings because the impulses are superimposed in an unpredictable manner.

4- A high rejection ratio m (e.g. m = 100 or more) can be achieved easily, the low end electrodes sometimes need to be screened to achieve this. However, high rates like these are not always needed in practice. A medium rate of the order of n = 100 to 500 can be achieved with samples of unequal capacitance with the identical insulation. This can be very convenient when measuring in the presence of unavoidable external discharges.

6.3 The Choice Between Straight And Balanced Detection

6.3.1 Straight Detection

In the absence of discharges, straight and balanced circuit reveal the same, the sample being discharge free. As soon as discharge appears, the question arises whether these occur in the sample or somewhere else in the circuit. It is not easy to answer this question with straight detection and the observer is left uncertain.

6.3.2 Routine Tests

Straighty detection is widely used for routine tests because of its simple procedure and the use of an earthed sample. An unskilled operator can connect one sample after the other in a present detection circuit and test it for freedom of discharge at the specified voltage. But when discharges are found the procedure must be extended and a more experienced observer must take over.

Straight detection is also used for monitoring long-term tests where a sample is aged by heat cycles, over voltage, and sunlight, and a constant check on the absence of discharge is needed.

6.3.3 Balanced Detection

Balanced detection is mainly used in research and development as well as in extensive testing of newly designed prototypes. It is also used for comprehensive testing after discharges have been found in routine testing in the presence of heavy disturbance in the power supply and for locating discharge in compound structure.

7. Testing of Specimens

Specimens having point plane electrodes of thickness 5mm were selected from a lot of specimens prepared. The hypodermic needle point electrode had a tip radius of curvature 5mm. Prior to testing, the specimens were inspected optically under 400 magnification microscope for any sign of flaws, voids and defects (such as air cavities and cracks) particularly at the needle tip, as well as between the spacing of electrodes. Those found defective were rejected and replaced by perfect or defect-free specimens.

Before starting partial discharge test on individual specimen the specimen was mounted in a test cell. The test cell consisted of a Perspex vassal measuring 320 mm x 50 mm, having six pairs of spring brass electrodes, which held the specimen firmly in position. The electrodes used to support the point electrodes of the specimens each had a 1mm diameter, 20mm long hole drilled down their centers to accommodate the shank of the hypodermic needle acting as a point electrode of specimen. The shanks fitted freely into the holes so avoiding any preloading of the needles. Pre-loading in this context is referred to pressing of needle when the specimen is clamped in position. The drilled hole produces a free play of the needle shank by providing only a very small or zero force. This produced electrical contact but avoid any mechanical stressing. A piece of aluminum foil was placed around and in contact with the needle shanks where they protruded through the surface of the specimen. In this way a good electrical contact between the brass electrodes and the point and plan electrodes of the specimens was ensured.

To avoid surface discharges during the experiment, the test cell was filled with clean insulating fluid, (polychrome biphenyls). The electrodes being fully submerged PCB type 48 was used since its reflective index is nearly the same as that of LDPE. In this way a clear view of the specimens electrodes was obtained through the microscope. [5]

The specimens once clamped, and the connections of the cell was made to the HV AC test source, extreme care was taken to ensure the test cell was at a safe distance from the apparatus to avoid accidental spilling of insulating fluid in case of discharge during the

experiment. All the requirements when completed, the partial discharge detection test conducted by following the steps given below:

1- The high-voltage terminal and ground terminal of the test set connected to the test cell contained the specimens to be tested. The ground terminal of the specimens connected directly to the power separation filter ground terminal.

2- The interlocked gates to the H.V test area were then closed.

3- The test set energized by turning the main power switch ON.

4- The detector display was set up to determine the phase relationship.

5- The system was calibrated by one of the recommended procedures.

6- Test voltage applied by depressing the start button and the voltage control adjusted according to the requirements. The high-voltage test source used in this experimental work ranged upto 30KV.

01KV applied to the first specimen for the specified time, 02 KV to the second specimen and so on upto 18KV to the 18^{th} specimen. The voltage increased to 19KV but most of the specimens failed to withstand at this voltage and break down of some of the specimens took place.

Such specimens were rejected and test was terminated beyond 19KV voltage.

7- Partial discharge for specified voltage and time for each specimen was measured and the corresponding damage to each specimen at the tip of point electrode was examined for the given partial discharge activity and time interval under 400 magnification through microscopes.

The observations of the experimental work are recorded in Tables [1] where the correlation between the magnitude of partial discharge and corresponding damage (in micron) to the specimens is plotted for each specimen.

8. Conclusions

In the light of investigations into the effects of partial discharges on the life of cables insulation, some conclusions are made which are stated as follows.

1- The electric field within the cavity must exceed the discharge inception field and a primary electron must be present to initiate partial discharge activity.

2- The primary electron must have sufficient energy acquired from the electric field so that electron multiplication produces a critical avalanche size for partial discharge activity to begin.

3- The voltage at which partial discharge starts depends on stress in the cavity and the B/D strength of the cavity, where the B/D strength of the cavity further depends on its dimensions and is governed by the type of gas and gas pressure in the cavity.

4- Partial discharge activity increases with the increase of applied voltage provided that information is available about:

(a) The amount by which the voltage is above the minimum B/D voltage of the cavity and
(b) The number of electrons generated per second.

5- It has been closely observed from all these experimental results that partial discharge cause Damage/Degradation to the insulation. The Damage/Degradation is directly related to the partial discharge activity. Thus Partial discharge adversely affect the performance of the insulation and thereby shorten its life. Mathematically the relation regarding the life of the insulation and the partial discharge can be developed in future of the form as given below.

$L \propto 1/q$
Where
L= Life of the insulation, and
q= Partial discharge.

9. Remedial Measures

The following remedial measures can be adopted in order to reduce the effects of partial discharges;

1- The insulation material production should be in a very neat and clean environment in order to avoid the impurities, voids and inclusions etc.

2- The power cables of every rating must be provided with earthing sheaths/strips. ■

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INVESTIGATING THE EFFECTS OF PARTIAL DISCHARGES ON LIFE OF INSULATION OF 11KV CABLES

By

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ABSTRACT

During the last two decades the voltage rating of underground transmission cables has increased considerably and in near future the electrical stress across the polymeric insulation will also be increased. Hence the need for better material to withstand high electrical stresses has become imperative [1]. The most widely used insulation in these cables is polyethylene and this material is known to degrade as time passed. In practice, the cable insulation service-life depends on many factors such as dielectric stress, temperature, thermal stresses, presence of voids, contaminations such as water and chemical substances, over voltages and mechanical stress. Since long time it was generally accepted that the intrinsic breakdown strength was the most important parameter when designing an insulation system. However, the technical development resulting in better utilization of materials has led to considerable increase of electrical stress levels. Presently, in many cases the electrical stresses in service have reached such levels that chemical-thermal stability and high intrinsic dielectric strength of the insulation system affect the reliability. In addition, some more complex phenomena must be considered, e.g. the PD characteristics of the insulation system, which influences in many cases the reliability of the system. This is specially true for power cables and H.V. capacitors. Due to this fact there is increasing demand from customers for dielectric design proof test with special emphasis on PD characteristics.

1.0 Introduction

11KV underground power cables are used extensively for power distribution and many of these cables have been in service for a considerable period of time. For low voltage distribution in thickly populated areas, cables are mostly used. The cables have also been designed for high-voltage transmission (E.g. 220kv power cable is used by WAPDA at Hydel Power Station Mangla to transmit power from the generating station to switchyard), but their use is limited due to economic constraints. Cables as compared to overhead lines have the following advantages.

(1) Cables are not subject to supply interruptions caused by lighting or thunderstorms, birds and other severe weather conditions such as rain and snow.
(2) It reduces accidents caused by mechanical damage of the conductors.
(3) It's use is comparatively environment friendly.

The type of cables to be used at a particular location is determined by the mechanical conditions and the voltage at which it is required to operate. Usually the operating voltage decides the type of insulation and cables are placed in various categories.

In early sixties, polymeric materials have been gradually replacing rubber and oil impregnating paper as electrical insulation in underground power cables.

Polymers such as low density polyethylene (LDPE) and cross linked polyethylene (XLPE), have excellent dielectric properties and are eminently suitable as insulation for both transmission and distribution class of cables.

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In order to investigate the effects of PD on the life of insulation, the most important are the voids and inclusions, which cause most common failure of the HV cables insulation. These are generally produced during manufacturing or operation. Such voids and inclusions act as defect centers or weak points and reduce the dielectric strength of the insulation considerably. These defects cause local overstressing by the electric filed and can undergo local internal discharges. This fact leads to progressive erosion at the defects in the material which can lessen the life of the cable. For the above-mentioned reasons, HV power cables are today subjected to elaborate postproduction quality tests and particularly to PD measuring tests in order to detect the possible damage caused by these discharges to the insulation. As we know that if cables are free from manufacturing faults, discharges at micro voids inevitably present in cast or extruded insulation which may lead to discharge failure. Furthermore, as each defect has its own particular degradation mechanism, it is important to know the correlation between discharge level and the size of defect/damage.

Therefore recognition of internal discharge and their correlation with the size of defects is considered in the present work in order to answer few questions discussed above.

2.0 Phenomena of Partial Discharge in Solid Insulators

2.1 Definition of Partial Discharges

Electric discharges that do not completely bridge the electrodes or discharges that bridge a part of the dielectric are called partial discharges [2].

Partial discharge in an electrical B/D phenomenon that is confined to localized regions of the insulating medium between two conductors at different potential. The localization of the discharge may be the consequence of an electric field enhancement restricted to a region that is relatively small compared with the dimensions of the space or gap between the conductors. The field enhancement can be associated with the abrupt change in the nature of the insulating medium that may be caused by voids in solid dielectrics or gas filled spaces at dielectric – conductor or dielectric – dielectric interfaces [3].

2.2 Phenomena of partial Discharge

The PD phenomena are inherently self-quenching. This characteristic arises either because the electric filed strength beyond a certain point is too low to support continued growth of the discharge activity acts to reduce the local electric field strength to a level insufficient to sustain the discharge. Because of its self-quenching nature, the PD process is characteristically pulsating and manifests itself as current pulses in external circuit.

The PD phenomenon that occurs around conductors in air or other gases is often referred to as corona. Corona discharges can, under some conditions, exhibit a non-pulsating characteristic for dc voltage which is associated with the formation of steady glow. This type of corona discharge is not self-quenching, it is not included in the category of pulsating PD phenomena considered here.

A necessary condition for PD formation is that a portion of the volume containing an electronegative gas, such as air, have an electric field-to-gas density E/N greater than the critical value $(E/N)_C$ at which gas ionization by coefficient α equals the electron attachment coefficient η. This ensures that rate of ionization by electron collisions exceeds the rate of electron attachment to molecules required for discharge growth. If this condition is satisfied, a PD can form.

For sufficiently large discharge gaps and high electric filed strengths, PD can occur under constant voltage when solid insulating surfaces are present [4, 5, 6].

However, charging of insulating surfaces will also occur as soon as PD activity begins [4,5,7] and depending on the insulator and its surface properties, the dissipation of PD generated surface charges can take many minutes or even hours [7]. In some cases the PD activity produces permanent or quasxi-permanent trapping of charges on the surface [5].

The probability for PD initiation can be expected to increase as [E] increases above the onset value. The mechanisms of PD initiation on the +ve and –ve half cycles will be different if the discharge gap is not symmetrical in its geometry and material composition. Electrons can presumably be ejected by an electric field much more readily from a negatively charged insulator surface than from an uncharged surface. Because of the relatively long times between PD events on successive half cycle at power frequencies, ions and metastable species in the gas are unlikely to contribute significantly to discharge initiation within small gaps or voids in or near solid dielectrics. The differences between the positive and negative discharge initiation mechanisms will introduce additional asymmetries in the PD behavior.

2.3 Classification

There are four types of discharges.

1. Internal discharges (Fig. 1 and 2)
2. Surface discharges (Fig. 3)
3. Corona discharges (Fig. 4)
4. A special case is formed by Discharges in electrical trees (Fig. 5) which may be considered as internal discharges of specific origin.

2.4 Inception of Internal Discharges

Internal discharges occur in inclusion of low dielectric strength. Usually these are gas filled cavities but oil-filled cavities also can break down and cause gaseous discharges afterwards [2].

2.4.1 Gas-Filled Cavities

Solid insulation systems typically also include gas gaps or voids either caused by different layers of insulation and interfaces or by improper manufacturing of the solid insulating material. In those small gaps PD is very likely to occur at much lower fields than the typically with-stand capability of the solid insulation.

A frequently occurring inclusion is the gas filled cavity. It can occur in extruded plastics, cast resins, lapped resin-impregnated paper. The voltage at which the discharge starts depends on the stress in the cavity and the B/C strength of the cavity. The stress in the cavity can be calculated in some cases. If a flat cavity is situated perpendicular to the electric field [(a) in Fig. 2] is 3E/1 + 26 times that in the dielectric. The stress in the cavity, if the cavity is long and parallel to the electric field, tends to be equal to that in th dielectric [(c) in Fig. 2], such cavities tend to be dangerous as they cause considerable field concentrations after B/C.

The cavity [(d) in Fig. 2], which is situated in longitudinal field, belongs to the same category [2]. PD that are purported to occur in solid insulation actually develop with in voids or cracks that contain gas, or along the surfaces at gas-solid interfaces [3]. Using broad – band detection methods, it has been shown that PD pulsar can have a variety of shapes that depends on the type and pressure of the gas that is present.

2.4.1.1 Hydrogen Filled Cavities

A-PD appear first in virgin cavities (never previously subjected to discharges), but their direction never exceeds – 10s. They are quickly replaced by B-PD which constitute a very stable regime. The transition to C-PD was never observed.

2.4.1.2 Nitrogen Filled Cavities

The discharge regimes are similar to those observed with H2 except for some cases where C-PD are observed.

The breakdown strength of the cavity depends on its dimensions and is governed by the type of gas and the gas pressure in the cavity. The discharge in a cavity bounded by insulating material occurs at approximately the same voltage as between equally spaced metal electrodes. Although the gas and the gas pressure may be unknown at the start of the cavity, in the long run it will adopt the gas and the gas pressure of the surrounding medium. This is caused by diffusion.

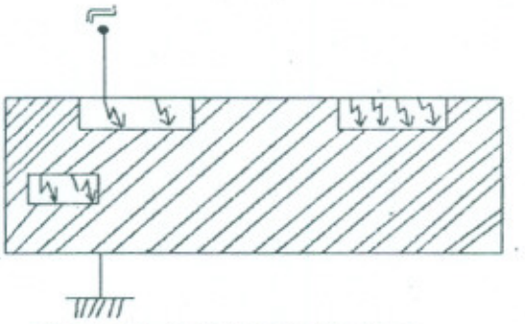


Figure 1. Internal Discharges

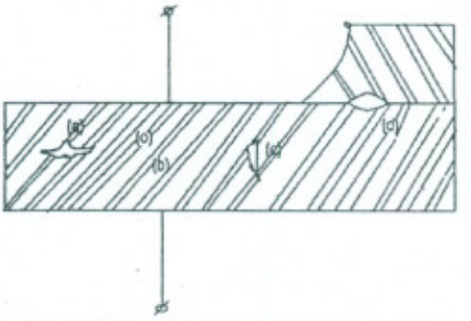


Figure 2. Internal Discharges

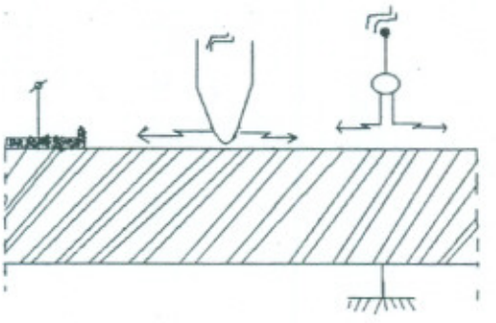


Figure 3. Surface Discharges

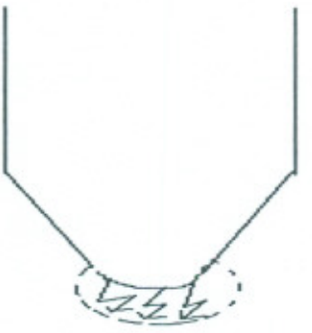


Figure 4. Corona Discharges

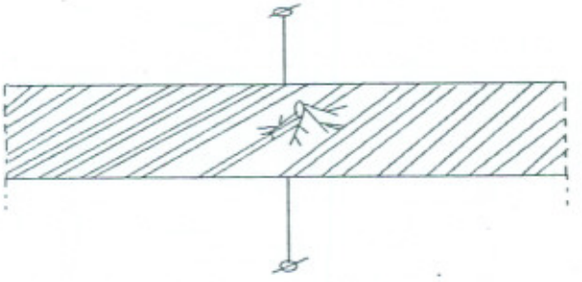


Figure 5. Discharges in Elect. Trees

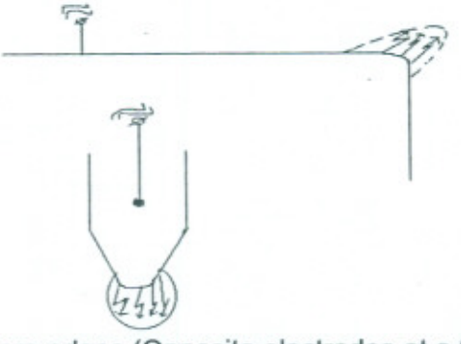


Figure 6. Corona at sharp edges (Opposite electrodes at a fair distance)

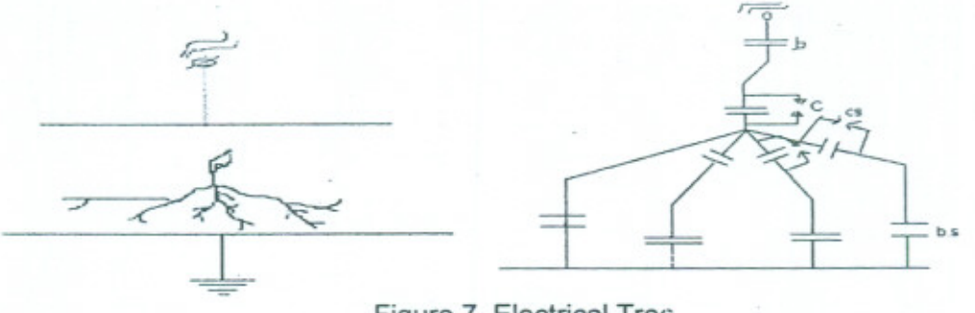


Figure 7. Electrical Tree

The statistical time lag, or the time required for a discharge-initiating free electron to appear within a cavity, increases with a decrease in cavity size. Consequently, very small cavities may not develop detectable partial discharge activity within the relatively short duration of voltage application of the quality assurance test. These cavities may pass undetected by the test, but under continuous test stress of normal operating conditions, may undergo partial discharges. PD is assumed to be any type of localized pulsating discharge that does not immediately result in a complete electrical breakdown. Thus, it includes electron avalanches as well as large streamer type discharges since the PD phenomenon is assumed to be a type of gas discharge. The primary effects of solid or liquid boundaries which may be present are assumed, (1) to modify the local electric field within the gaseous region where the ionization takes place and (2) in some cases to influence secondary electron production at the surface.

Several factors may cause the B/D voltage to be lower than predicted. The walls of the cavity may be covered by static charge, either produced when the cavity was formed or left after previous discharges, this may cause up to 20% variation. Semiconducting layers may occur on the walls of the cavity, more or less short circuiting the cavity. This may cause a considerable increase of the stress at which the cavity breaks down [2]. Ions created by prior PD pulses can effect subsequent PD initiation in two ways, first by forming a space charge cloud that can influence the field strength at the discharge initiation site and secondly by directly causing

release of electron by collisions with surfaces or gas molecules. Some more factors which affect the PD activity in the gaseous cavity are given by [3].

These are:-

(1) Probability of initiatory electron injection as a function of electric field strength & location.
(2) Dynamics of dielectric surface charging.
(3) Growth rate of discharge induced cavities in liquids.
(4) The rates of discharge-generated ion space charge and/or stable species dissipation.
(5) Fluctuation in gas density or composition.
(6) Presence of ionizing radiation.
(7) Memory propagation associated with the influence of residuals from previous PD pulses on the initiation and development of subsequent pulses.

2.4.2 Oil Filled Cavities

The mechanism for initiation of PD in liquid media are more complex than those in either gases or at gas-solid interfaces. The initiation mechanisms are more complex because of the necessity of vapourization phase resulting from localized heating of the liquid by injection and transport of charge species. It is not always possible in the case of liquids, to think of discharges initiation as arising from the introduction of a single electron into a high – field region. The possible mechanisms of charge injection and conduction in liquids that could result in PD formation were reviewed by Schmidt. In this paper he discussed the various stages of electronic B/D in liquids. The initial stage of electron injection into a liquid can be accounted for by processes comparable to those that occur in gases e.g, field emission and photoelectron emission from surfaces cavities filled with oil are found between layers and in butt gaps of oil impregnated paper insulation such as in transformer windings and in cables. The stress in an oil-filled cavity can be calculated in a way similar to that of the gas filled cavity. The most frequently occurring case is a cavity which is flat in a direction perpendicular to the direction of the electric field. Then the stress in the cavity is E2/E1 times as large as in the dielectric, where E1 is the dielectric constant of the oil and E2 that of the solid dielectric.

According to, during the lifetime of the cavity, it first grows in size, then detaches from the needle and finally breaks apart and collapses, moving away from the tip as it does so. The structure of the cavity appears to be approximately spherical at its inception and the cavity may grow by stable expansion, that is, by relatively uniform expansion, or by the growth in amplitude of instabilities in the cavity wall. Optical and photographic measurements indicate that electrical B/D of liquid dielectric in non-uniform fields is usually preceded by the formation of low-density regions, presumably gaseous bubbles or cavities. Recent correlation analyzes of simultaneous electrical and optical data indicate that bursts of pulsating PD occur during cavity growth in liquid.

2.5 Inception of Surface Discharges

Surface discharges may occur if there exists a stress component parallel to a dielectric surface. This applies to bushings, ends of cables, the overhang of generator windings, and where a discharge from outside touches the surface. The discharge affects the electric field so that in general, the discharges extend beyond the region where the original surface component of the electric field was high enough to cause discharges [2].

In the case where ac voltage is applied across the gap, the field reverses every half-cycle so that the charge that is deposited on the dielectric surface by PD on one half cycle will enhance the field in which PD are found on the next half-cycle. This means that a PD process that is ordinarily quenched under dc voltage can be kept alive under a.c. voltage so that one or

more PD pulses will appear in each successive half-cycle. Because of the field-enhancing effect of surface charges formed during the previous half-cycle, the PD pulses formed in solid dielectric cavities or on surfaces will tend to initiate preferentially near the zero crossing or on the rising portion of the applied ac voltage [6].

2.6 Inception of Corona Discharges

Corona discharges occur in gases at sharp point in the electrical field (Fig 6). That occur usually at the high voltage side, but at sharp edges at each potential or even at half-way the electrodes also may cause corona discharges.

Although the distance between electrodes may be large, the field concentration at sharp edge causes, nevertheless, a partial break down of the surrounding air.

Discharge tests over 100kv can be troubled seriously by corona at sharp edges. High voltage leads and connection should be rounded – off and protrusions at earth potential avoided. Even wires or chips of Metal lying-in the laboratory floor can cause unwanted discharges, therefore a clean laboratory flood is essential for trouble free testing [2].

1. Inspection of the corona is not a function of field strength but of the absolute voltage. A sharp point at a height of some decimeters above earth causes corona at the same voltage as a sharp edge at a high-voltage rail several meters above the lab floor.

2. Corona can be expected at fairly low-voltage and construction should be designed with the utmost care and detection circuits laid out carefully. The smallest disturbance may cause corona especially above 100kv by a piece of wire on the floor or sharp edge somewhere in the vicinity of the test and can cause hours to be wasted hunting for the cause of a disturbance.

2.7 Discharge by electrical Treeing

PD activity in cables insulated with polymer materials is often associated with the one set of trees [9] formed during the process of aging. These trees are composed of either gas-containing micro channels or material of low density that can be readily vaporized such as water.

Electrical trees start form defects in the insulation (Fig 7). After tree has progressed for some time, the stem and the larger branches grow hollow. Considerable discharges occur in these hollow spaces and form a special case for internal discharges, in contrast to the normal case, these discharges are very unstable as the tree may grow rapidly. No detectable discharges are seen for a long time during incubation, hours, weeks or even years can pass, depending on the applied voltage. Then treeing set in, discharges become visible and grow so rapidly that they may cause B/D inane extremely short period, some times in seconds or minutes. In order to study the discharges in the tree the voltage must be decreased to prevent a rapid B/D [2].

3.0 Detection of Partial Discharge

Partial discharge detection has grown into an indispensable tool for the evaluation of modern insulation construction. At least 4-steps are required for this judgment, (1) detection: the observation determined with certainty whether discharges are present or not (2) measurement: if discharges are present the magnitude of the discharges must be ascertained. A physical quantity must therefore be chosen which is both relevant to the harmfulness of the discharge and can be measured with one of the discharge detection methods (3) evaluation: estimation must be made of the type and the danger posed by the detected discharges. (4) Location; the

location of the cause producing partial discharge However, when using all the information that can be drawn from a well-performed discharge test, valuable information can be supplied on the quality of the insulation under test. Furthermore, partial dischage measurement system almost innovatively involves a strong interaction between the test object and the measurement system. Reproducibility of measurement in the area of particular discharge PD detection in electrical apparatus and cables is diligently strived for but is extremely difficult to attain, even when measurements are carried out with equipment having identical specified sensitivities in PC per division and the measurement are performed on the same test specimen. It is found that a given specimen when tested in rapid succession will still exhibit some variation in the detected discharge pulse amplitudes at the discharge inception voltage, and the discharge inception and extinction voltage themselves will be slightly different for every applied voltage excursion step. There are various causes that may be advanced to account for the recorded disparity in measurement on both short and long term basis. These causes may be associated in part with the statistical variations in the discharge process itself, changes in cavity configuration, vapor pressure and gas composition changes within the occluded cavities due to the diffusion process and evaluation of different gases resulting from chemical degradation, and change in the nature of the cavity wall as a result of pitting and arising from the physical degradation inherent with ion and electron bombardment of the walls as well as the deposition of compounds on the walls due to the chemical degradation effect themselves.

4.0 Quantities Related to the Magnitude of Discharges

Several quantities that could be chosen to measure the magnitude of discharges will be discussed here.

4.1 Charge Transfer

The charge Q1, which is transferred in the cavity (or in the case of surface discharge, the charge transferred along the surface) could be taken as a measure. If the sample is large compared with the cavity as will usually be the case, this charge transferred is equal to:

$$Q1 = (b+ c) V \qquad (1)$$

Where b and c are cpacitances and V is voltage.

As the deterioration of a dielectric certainly is related to the charge transfer in the defect, Q1 would be an attractive choice. However, Q1 cannot be measured with a discharge detector and is therefore not a practical choice [2].

4.2 Apparent Charge Transfer in the Sample

The displacement of charge q in the leads of the sample can be taken and is defined as "that charge which, if injected instantaneously between the terminal of the test object, would momentarily, change the voltage between its terminals by the same amount as the partial discharge itself [2]. This quantity is equal to:

$$Q = b \times \Delta V \qquad (2)$$

It causes voltage drop $(b \times \Delta V) / (a+b)$ in the sample. Most discharge detectors respond to this voltage drop and are thus capable of determining Q [2]. However the capacity b in series with the defect, is not related to the defect and due to the following problems, Q seems therefore not to be a good choice.

1- The apparent charge induced on the electrodes of an insulation system depends on various parameters, which are not all related to the type of defect (geometry, materials, size etc). It therefore does not characterize the defect sufficiently.

2- The apparent charge as caused by the rearrangement of image charges on the electrodes depends on the position of the defect within the insulation system and on the local field at this position.

5.0 Choice of Q as Measure for Discharges

5.1 Energy Relationship

The apparent charge q that flows through the lead of a sample can be related to the energy p of the discharge as follows

$$P = \tfrac{1}{2} C (U^2 - V^2)$$
$$P = \tfrac{1}{2} C (U+V) (U-V)$$
$$P = \tfrac{1}{2} C X \Delta V X (U + V) \quad (3)$$

Where ΔV is the difference between voltages U and V.
If V is neglected, the answer becomes about 10% too low

$$P = \tfrac{1}{2} C X \Delta V X U \quad (4)$$

And

$$U = b / (b+c) X V_1$$

Where V_1 is the inception voltage at which the sample starts to discharge then

$$P = \tfrac{1}{2} C X \Delta V X (b / (b+c)) X V_1 \quad (5)$$

Neglect b as compared to c, so that the answer becomes several percent too high and the pervious neglect is almost cancelled out. Then:

$$P = 1/2\ b\ \Delta V \times V1$$
$$P = \tfrac{1}{2} X q X V_1 \quad (6)$$

V1 is usually expressed in volts r.m.s so that

$$P = 0.7 \times q \times V1$$

The discharge magnitude q is thus a reasonably good measure for the discharge energy p at the discharge site, which causes the deterioration of the dielectric [2]. In contrast to the energy in the discharge gap, it is very easy to determine the oscillating energy concerning the voltage source and the test object.

5.2 Relationship to Size of Defect

The discharge magnitude q=b x v can be related to the size of the discharge site as follows. The area of the site is A and the thickness of the dielectric is d. If the thickness of the discharge gap is small as compared to the insulation thickness d and the electric field is taken to be homogeneous.

$$B = \varepsilon_0 \varepsilon x (A/d) \quad (7)$$

And consequently

$$q = \varepsilon_0 \varepsilon x A x V x (1/d) \quad (8)$$

5.3 Choice of q

The characteristics of the transfer of charge q make it an attractive quantity for the measurement of discharges. These characteristics are:

1) q is directly related to the energy in the discharge.
2) q is directly related to the size of the defect.

3) q can readily be measured with an electrical discharge detector.
4) it can be shown that the harmfulness of a discharge is related to the order of magnitude of q in power of ten.

It must be emphasized that the discharge magnitude is not equal to the charge transfer in the cavity. The charge transfer q1 is usually several tens of times large than the apparent charge q. The only disadvantage in using q as a measure foı discharge is that q is inversely proportional to the insulation thickness d. thicker insulation are thus measured with less sensitivity than thinner ones [2].

6.0 Partial dicharge detection methods

6.1 The Chemical method

This consists of analyzing the gas in a sealed device (GIS for instance) and determining the decomposition product concentration, by gas chromatography, spectroscopic measurements, etc. This gives an indication of the aging of the apparatus, and can be used for periodic checking, but not to monitor the device permanently.

6.2 The Electromagnetic Waves

Radiation by the discharge can be detected with spectrum analyzer connected to a coupling device, consisting of an insulated electrode located at a given distance from the HV conductor. The spectrum due to a given defect depends on the defect geometry, and the analyzer may not be sensitive enough in a particular frequency range. Also it is not possible to localize the discharge inside the apparatus.

6.3 Acoustical Method

This method used sensors located inside or outside the shielded device. Discharge in air, like corona and surface discharge can be located very well by acoustic methods [2].

6.3.1 Applications of Acoustical Method

In oil-insulated installations, like transformers, an ultrasonic transducer can be immersed in the insulating oil to detect the P.D. Acoustic detection can also be used to locate discharges in high voltage equipment, such as transformers or gas-insulated switchgear.Oil-insulated capacitors of multi-microfarad size can be tested readily with ultrasonic transducers coupled to the steel tank.

6.3.2 Advantages of Acoustical Method

The acoustic method is an excellent aid for trouble shooting when performing electrical discharge tests. It uncovers disturbing discharges, such as corona at HV leads of unwanted surface discharge [2]. This is also very sensitive to irrelevant noises such as rain patter, wind etc, so that the signal has to be analyzed in the time or frequency domain by Fourier Transform in order to eliminate noise from erratic phenomena. The sensitivity of this method also depends on the shape of the defect. As with all Nonelectric detection methods the magnitudes connot be measured. However, detection is not affected by external discharge, so that good results can be obtained in electrically noisy surrounding. For these reasons acoustic detection is also used to monitor equipment for discharges during service. Electrical Signals from switching, corona discharges, over voltages, etc. do not interfere with this test. So that reliable although insensitive supervision is obtained. The ultrasonic detector allows rapid checking of energized equipment but not absolute and provides only an indication of change of state.

6.4 Optical Method

Due to the limitations of the former methods it was thought promising to investigate the possibility of detecting partial discharge by observing the light they emit. Light detection can only be used for surface discharge and corona.

If the test place can be changed into a dark room visible or ultraviolet light can be picked up and used for detection and location a dark room visible or ultraviolet light can be picked up and used for detection and location [2]. For experimental conditions near the threshold for PD activity, PD occurs infrequently and is separated by time intervals that are widely distributed. Also the lifetime of cavity is of the order of microseconds. These characteristics present a technical challenge recording a short-lived event that many occur essentially at random. Several approaches using optical or photographic techniques and broadband current detection have been successfully employed.

6.4.1 Advantages of optical method

1- Light detection is an excellent auxiliary method for partial discharge detection and provides a sharp location at a good sensitivity, and is unaffected by electric disturbance in the test circuit or the mains.

2- Photographic records usually are made at various test voltages, around and above the inception voltage. This has the additional advantage that it is a simple method, any household camera can be used. A sensitivity of at least 1PC can be reached.

7.0 Conclusions

Solid insulation system typically includes gas gap or voids either caused by different layers of insulation and their interfaces or by improper manufacturing of the solid insulating material. Cavities in these materials can also be generated by excessive mechanical load, especially when combined with thermal cycling. The gases and partial pressures within the cavity will have a major impact on the discharge characteristic. If the electric field in the gas within a cavity is raised beyond the minimum breakdown field, a partial discharge (PD) can take place. This depends on the gas and gas pressure within the cavity. ■

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FRACTIONAL REFINEMENT OF FERRITE DURING CONTROLLED ROLLING OF CARBON STEEL

By

Dr. Liaqat Ali * and Gul Hameed Awan **

ABSTRACT

The role of controlled rolling is to introduce a high density of sites in the austenite phase, for the nucleation of ferrite grains, during transformation, by controlling the hot rolling conditions. It was investigated during the present work, whether the refinement of ferrite grains was essentially caused by the dynamic recrystallization of austenite that occurred during high temperature rolling (rolling temperature 1050°C), or by avoiding the recrystallization of austenite, by rolling just above the Ar_3 temperature. It was found that refinement essentially resulted from increased nucleation of ferrite on intragranular sites such as deformation bands and dislocation sub-structure, as well as on elongated austenite grain boundaries when the rolling was conducted just above the Ar_3 temperature.

INTRODUCTION

The principal objective of thermomechanical treatment is to obtain a fine final structure, such as ferrite, as the refined structure enhances both strength and toughness of the hot rolled materials. The final structure and mechanical properties of the hot rolled structural steels depends largely on the state of austenite at the onset of its transformation during cooling. The structural state of austenite at the end of each strain cycle under a given set of deformation conditions (temperature and strain rate ε°) is governed by the relative magnitude of hardening and softening processes [1,2]. For single-phase austenite, the hardening process is simply work hardening, and the possible softening processes are the dynamic recovery and the recrystallization. Hardening processes dominate at low temperature (T), and high strain rate (ε°). At higher temperature and lower ε°, dynamic recovery and dynamic recrystallization occurs.

Hot deformation at elevated temperature can refine or coarsen the austenite grain size as a consequence of dynamic recovery and recrystallization processes taking place during deformation. In addition softening of dynamically recrystallized austenite after deformation has been attributed to three distinct processes: static recovery, classical recrystallizatioan and a metadynamic (i.e., post dynamic) recrystalization [3]. The temperature and the amount of reduction strongly influence recrystallization behaviour. The critical reduction for recrystallization increases with a decrease in rolling temperature [4, 5, 6].

Deformation of austenite in the non-recrystallization region will produce an effective increase in grain boundary area due to the introduction of deformation bands [4] and annealing twins [7] in elongated, unrecrystalized austenite grains as well as a real increase due to the change of grain shape. These deformation bands and annealing twins provide additional sites for ferrite nucleation, which leads to further refinement of ferrite grain size.

Ouchi (et al) [8] have shown that a minimum rolling reduction of about 30% is needed to form deformation bands. Inagaki [7] used crystallographic and morphological techniques to present a clear picture of deformation bands. He concluded that the deformation bands were in fact the annealing twins that were deformed and extended in the rolling direction, and their width decreased with increased rolling reductions. Inagaki [7] also observed that the deformation of austenite not only increased the total surface area of the austenite grain boundary and the area

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of annealing twin boundaries but also introduced a heavy local deformation into the region near these boundaries. Both of these effects were held to be responsible for the enhancement of ferrite nucleation.

EXPERIMENTAL DETAIL

The material used in this investigation was a low carbon silicon manganese steel. The composition of the steel (in wt. %) was; 0.19% C, 0.32% Si, 0.76% Mn, 0.005% P, 0.008% S, 0.12% Ni, 0.015% Al, 0.22% Cu. It was obtained as a rolled plate of 12.5 mm thickness and 76.00 mm width. Test specimens for rolling were machined to the width of 35.00 mm and length of 50.00 mm. The thickness of the specimens was so devised that they were of the same thickness, 5.0 mm, after rolling. This ensured repeatable cooling after rolling. A chromel–alumel thermocouple was inserted through a hole drilled into the slab, and its junction situated in the middle of the slab (transverse direction). The hole was packed with alumina wool. The thermocouple wires were insulated with ceramic beads and tied to a handling rod.

The experiments were divided into two parts: For part (i); simultaneous deformation and recrystallization of austenite took place at high temperature. All the specimens for 0%, 10%, 20%, 30% and 50% reductions were austenitized at 1100 °C for 30 minutes to produce a constant grain size of 78 μm. After 30 minutes, the specimens were cooled to 1050°C (rolling temperature) on the run-table before being passed through the roll gap.

For part (ii) austenite was deformed just above the Ar_3 temperature. All the specimens were austenitized at 1100 °C. After 30 minutes, they were transferred into another muffle furnace maintained at ~900 °C. The specimens were inserted in the furnace with its handling rod placed between the rolls. After setting the roll gap for the desired reduction, the specimens were cooled to 850 °C on the run-table before being passed through the roll gap.

Three different post deformation cooling-rates were employed during the present study. These cooling rates were obtained by:

- Accelerated air cooling (AAC).
- Still air cooling (AC).
- A box containing vermiculite powder (VC).

In order to get a correlation between the austenite grains (on exit from roll gap) and the final ferrite grains, slabs of various reductions were quenched into iced-brine (BQ) at -5°C. A swift point counter was used to determine the volume fraction of the different phases in each specimen. The average grain size (mean linear intercept) was measured from photomicrographs using the mean linear intercept method [9].

The aspect ratio of austenite grains was taken simply to be the ratio $\overline{L}_{\gamma L}$ (longitudinal)/ $\overline{L}_{\gamma T}$ (transverse). For these elongated grain structures, $\overline{L}_{\gamma}$ was taken to be equal to $\sqrt{\overline{L}_{\gamma L} \cdot \overline{L}_{\gamma T}}$ and Sv_{γ} to be $\frac{2}{\overline{L}_{\gamma}}$.

Vicker hardness measurements were made using a 30 kg load, and the average of 10 readings was taken.

RESULTS AND DISCUSSION

Part I: Effect of High Temperature Reduction on Ferrite Refinement

Ferrite grain sizes, ferrite volume fractions, hardness values and fractional refinement are given in Table 1. Each specimen is coded according to the treatment it was given. The left hand number represents the amount of rolling deformation and right hand letters represent the cooling medium used (i.e., AAC = accelerated air cooled, AC = air cooled, VC = Vermiculite cooled, BQ = Brine Quenched). All the specimens were austenitized at 1100 ±6 °C for 30 minutes.

Ferrite grain size decreased with increasing amount of reduction for all the specimens. For any amount of deformation, the ferrite grain size was smaller for the faster cooling rates.

The degree of grain refinement is better represented in terms of the fractional refinement 'F.R.' [10], which was calculated according to the expression:

$$F.R. = \frac{\bar{L}_o - \bar{L}_R}{\bar{L}_o}$$

Where;

$\bar{L}_o$ is the mean linear intercept of ferrite after zero reduction.

$\bar{L}_R$ is the mean linear intercept of ferrite after 'R' reduction.

If the relationship between austenite and ferrite grain size remains unchanged, then fraction refinement of ferrite grains is directly related to the fractional refinement of austenite grains, and to changes in austenite grain boundary area.

F.R. of ferrite and austenite grains is plotted against rolling reduction in Figure 1. The top curve represent how ΔSV_γ behaves as a result of recrystallisation for the present steel. It was derived from austenite grain size measurement. Fractional refinement of ferrite was largest for accelerated air-cooled specimens and smallest for vermiculite cooled ones. For any amount of deformation, the fractional refinement was smaller for the slower cooling rates (Figure 2).

Part-II: Rolling Just above Ar_3 Temperature

These experiments were performed at temperatures just above the Ar_3 temperature. All the specimens were austenitized at 1100 °C for 30 minutes and rolled at 850 °C. The specimens were cooled in air and accelerated air only.

Results of ferrite grain size measurements, ferrite volume fractions, fractional ferrite grain refinements, hardenesses, austenite grain size, and austenite grain-aspect- ratios are tabulated in Table 2. Fractional refinements are plotted against rolling reductions in Figure 3. Also plotted are the experimental measurements of ΔSv_γ, where:

$$\Delta Sv_\gamma = \frac{Sv_{\gamma R} - Sv_{\gamma o}}{Sv_{\gamma R}}$$

This 'fractional difference' in austenite grain boundary area is equal to the fractional refinement of austenite grain size, since $\bar{L}_\gamma \propto 1/Sv_\gamma$. The curve labeled 'calculated' ΔSv_γ would be expected after plane strain rolling in the absence of any recrystlization.

It can be seen that ferrite grain size decreased with increased reduction, and fractional refinement increased with increased reduction. For all the specimens the faster cooling rate gave better grain refinement and higher values of fractional refinement.

Figure 4 shows a comparison between Specimens coiled at 1050°C and 850°C. This indicates that lower reduction temperature gave better fractional refinement and smaller ferrite grain sizes.

The austenite grain sizes determined in samples austenitized at 1100 °C rolled at 1050°C on rolling reductions are tabulated in Table 3.

In considering the relationship between austenite and ferrite grain structures, use was made of the idea that expanding or contracting the scale at which the austenite and ferrite grain structures were viewed would change $\overline{L}_\gamma$ and $\overline{L}_\alpha$, but not the number of ferrite grains per austenite grain, nor the ratio $\overline{L}_\gamma / \overline{L}_\alpha$. Thus, it can be written;

$$\frac{\overline{L}_\gamma}{\overline{L}_\alpha} = K$$

where K is a constant independent of austenite grain size, provided that the number of ferrite nuclei per austenite grain did not change.

Using the ferrite grain sizes listed in Table 1, the value of K (= $\overline{L}_{\gamma o} / \overline{L}_{\alpha o}$) was calculated to be 4.8 for accelerated air cool, 4.4 for air cool and 3.2 for vermiculite cool. If these values of K stayed constant after rolling, then it should be expected that F.R. (α) would be the same as F.R.(γ), and that the dependence of F.R.(α) on reduction would be the same for all three cooling rates.

Figure 1 demonstrates that this was not the case. F.R.(α) increased with reduction, but was lowest in the vermiculite-cooled material, highest in the accelerated-air-cooled material, and always much lower than F.R.(γ). It is apparent that either K was reduced by rolling, below the values established from undeformed material, to a greater extent the slower the cooling rate, or that the austenite grain size increased in the time interval between the exit from the roll gap and the beginning of transformation during cooling.

Table 3 lists ferrite grain sizes after rolling, the austenite grain sizes determined in specimens brine-quenched from the roll gap, and the values of K deduced from these. These values of K fall to less than half the values for undeformed austenite. It is possible that dynamically recrystallised austenite contains fewer sites for ferrite nucleation than austenite formed by transformation and grain growth. However, K continues to decrease beyond the reduction at which, it is believed, the dynamic recrystallisation was completed. A simpler explanation is that the austenite grain sizes established at the exit from the roll gap increased during cooling to the transformation temperature.

Figure 4 compares the increase in F.R.(α) due to rolling, for material rolled at 1050°C and at 850°C. Although rolling at 850°C yielded finer ferrite and greater fractional refinement than did rolling at 1050°C, the data presented in this way gives no indication that the origin of the grain refinement was any different in the two cases.

Figure 3 includes measurement of $\Delta S v_\gamma$ as well as F.R.(α). The broken line in the Figure represents a calculation of $\Delta S v_\gamma$ as a function of reduction based on the assumption that austenite grains elongated, without recrystallisation, to the aspect ratio expected in plane

strain rolling. It is seen clearly that measured values of $\Delta S v_\gamma$ lay close to the calculated line, indicating that the experimental conditions conformed very closely to the assumption. It is equally clear that the fractional refinement of ferrite greatly exceeded $\Delta S v_\gamma$. It follows that K was greatly increased by the rolling deformation. That is, the major distinction between the ferrite grain refinement resulting from rolling at 1050°C and at 850°C is that at 850°C the number of ferrite grains per austenite grain increased.

Table 4 lists for each rolling reduction at 850°C the measured values of $\overline{L}_{\gamma R}$, $\overline{L}_{\alpha R}$, and the value of K derived from them. For accelerated-air-cool, K increased from 4.3 at 0%R to 9.3 at 50% reduction. The number of ferrite nuclei per austenite grain increases as the cube of K, and so this variation reveals an order of magnitude increase in the ferrite nucleation rate (expressed as number of nuclei per austenite grain).

If the whole of such an increase in nucleation rate occurred at austenite grain boundaries, the resultant ferrite grain structure after complete transformation could not be equiaxed. The ferrite grains, growing from austenite grain boundaries would impinge long before the transformation was complete. They could then only grow inwards towards the centre of the austenite grain. Figure 5 shows that after 50% reduction at 850°C, the ferrite microstructure was reasonably equiaxed. This could only follow if both the grain boundary and intragranular nucleation rates increased in an appropriate proportion.

With the benefit of this insight, lines have been drawn in Figure 5 to suggest the position of prior austenite grain boundaries. Ferrite grains have impacted along these suggested austenite grain boundaries, but have not grown excessively long into the austenite grains because the interior of the austenite grains contained intragranularly nucleated ferrite grains. The result was a fairly equiaxed grain structure.

Table 1: Ferrite Grain Size in samples austenitized at 1100°Cand rolled at 1050°C

Specimen	Reduction %	Ferrite Fraction %	Mean Linear Intercept of α grain μm	HV_{30}	Fractional Refinement of Ferrite Grain
OAAC	0	73.7	15.2	163	-
OAC		77.9	16.6	159	-
OVC		80.7	22.5	146	-
10 AAC	10	74.3	11.2	161	0.26
10AC		79.3	13.7	155	0.17
10VC		81.7	20.4	145	0.09
20 AAC	20	75.5	10.7	156	0.30
20AC		80.1	12.3	158	0.26
20VC		82.5	17.8	147	0.21
30 AAC	30	77.3	9.7	157	0.36
30AC		81.3	11.6	155	0.30
30VC		83.7	16.6	147	0.26
50 AAC	50	78.8	9.1	154	0.40
50AC		82.1	10.7	150	0.36
50VC		85.5	15.1	143	0.33

Table 2: Ferrite Grain Size in samples austenitized at 1100°C and rolled at 850°C

Specimen	Reduction %	Ferrit Fraction %	Mean Linear Intercept of Ferrite Grain μm	$\bar{L}_{\gamma L}$ μm	$\bar{L}_{\gamma T}$ μm	Mean Linear Intercept of γ grain	Aspect Ratio	Fractional Refinement
0BQ		-	-	-	-	67.30	-	-
0AAC	0	75.5	15.7	-	-	-	-	-
0AC		78.4	16.6	-	-	-	-	-
10BQ		-	-	79.5	54.5	65.82	1.46	0.022
10AAC	10	77.1	9.95	-	-	-	-	0.37
10AC		80.0	11.2	-	-	-	-	0.33
20BQ		-	-	82.9	48.0	63.08	1.73	0.063
20AAC	20	78.2	8.95	-	-	-	-	0.43
20AC		80.4	10.00	-	-	-	-	0.40
30BQ		0	-	83.5	43.6	60.34	1.91	0.10
30AAC	30	80.5	7.4	-	-	-	-	0.53
30AC		81.5	8.2	-	-	-	-	0.51
50BQ		-	-	87.9	35.6	55.94	2.47	0.17
50AAC	50	81.67	5.99	-	-	-	-	0.62
50AC		83.00	7.4	-	-	-	-	0.55

Table 3: Values of $\bar{L}_{\alpha R}$, $\bar{L}_{\gamma R}$, $\bar{L}_{\gamma R^*}$ and K for Specimens Austenitised at 1100°C, Rolled at 1050°C

Re-duction %	Experi-Mental Value of $\bar{L}_{\gamma R}$ μm	Austenite Grain size Calculated on the basis of constant K values			A.A. Cool		Air Cool		Vermiculite Cool	
		A.A.C. $\bar{L}_{\gamma R^*}$ μm	A. Cool $\bar{L}_{\gamma R^*}$ μm	V. Cool $\bar{L}_{\gamma R^*}$ μm	$\bar{L}_{\alpha R}$ μm	$K=\frac{\bar{L}_{\gamma R}}{\bar{L}_{\alpha R}}$	$\bar{L}_{\alpha R}$ μm	$K=\frac{\bar{L}_{\gamma R}}{\bar{L}_{\alpha R}}$	$\bar{L}_{\alpha R}$ μm	$K=\frac{\bar{L}_{\gamma R}}{\bar{L}_{\alpha R}}$
0	73.00	73.00	73.00	73.00	15.2	4.8	16.6	4.4	22.5	3.2
10	33.80	53.7	60.30	65.30	11.2	3.0	13.7	2.5	20.4	1.7
20	30.30	51.4	54.10	57.00	10.7	2.8	12.3	2.5	17.8	1.7
30	24.60	46.6	51.00	53.10	9.7	2.5	11.6	2.1	16.6	1.5
50	19.00	43.7	47.10	48.30	9.1	2.1	10.7	1.8	15.1	1.3

Table 4: Values of $\bar{L}_{\alpha R}$, $\bar{L}_{\gamma R}$ and K for Specimens Austenitised at 1100°C Rolled at 850°C

Reduction %	Experimental Values of $\bar{L}_{\gamma R}$ μm	A.A. Cool		Air Cool	
		$\bar{L}_{\alpha R}$ μm	$K=\frac{\bar{L}_{\gamma R}}{\bar{L}_{\alpha R}}$	$\bar{L}_{\alpha R}$ μm	$K=\frac{\bar{L}_{\gamma R}}{\bar{L}_{\alpha R}}$
0	67.3	15.7	4.3	16.6	4.1
10	65.8	9.95	6.6	11.2	5.9
20	63.1	8.95	7.1	10.0	6.3
30	60.0	7.4	8.1	8.20	7.3
50	56.0	5.99	9.3	7.4	7.6

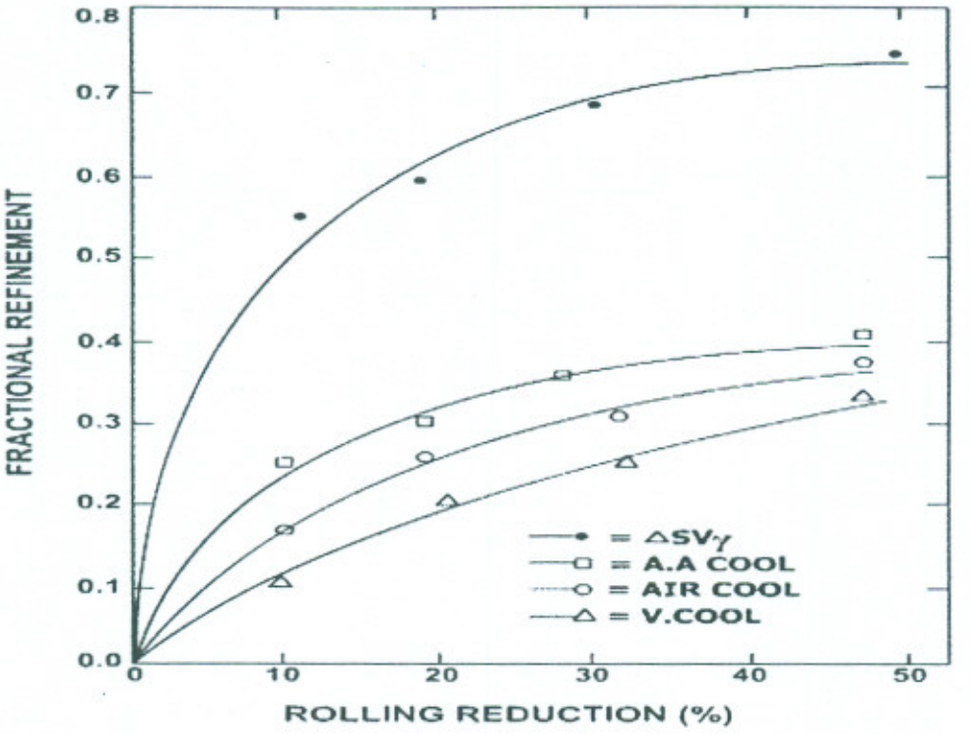


Fig. 1 Fractional refinement of ferrite and austenite grain sizes plotted against reduction for specimens rolled at 1050°C

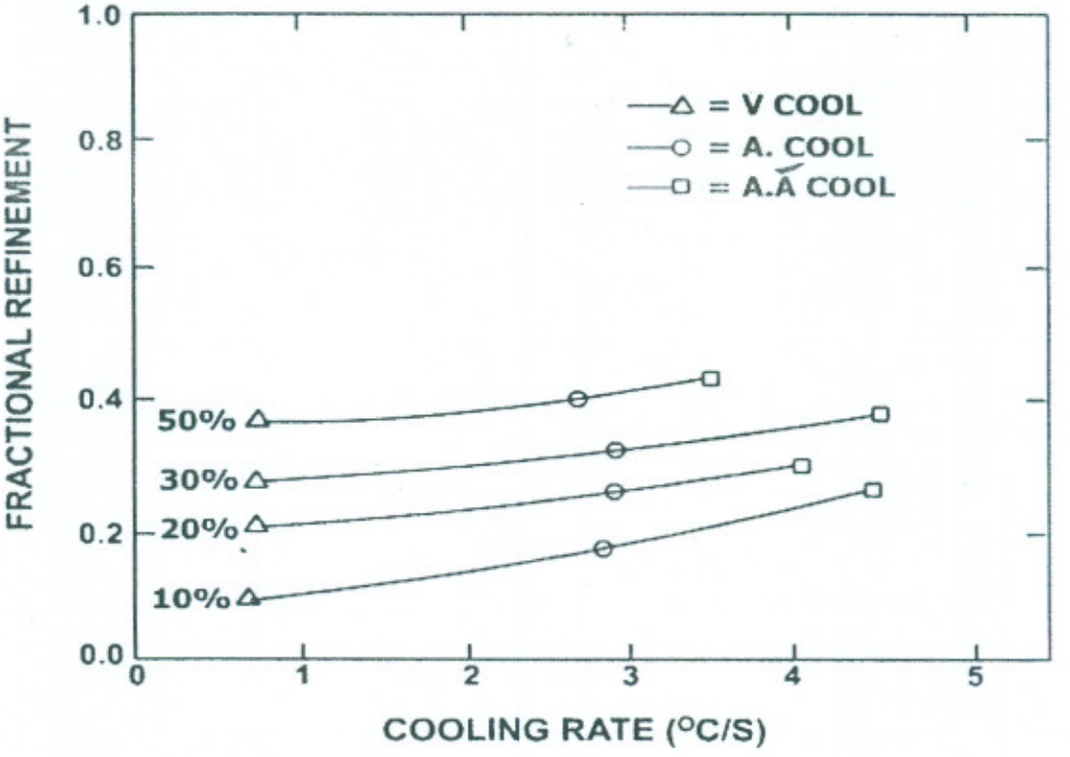


Fig. 2 Variation of fractional refinement of ferrite with cooling rate for specimens rolled at 1050°C

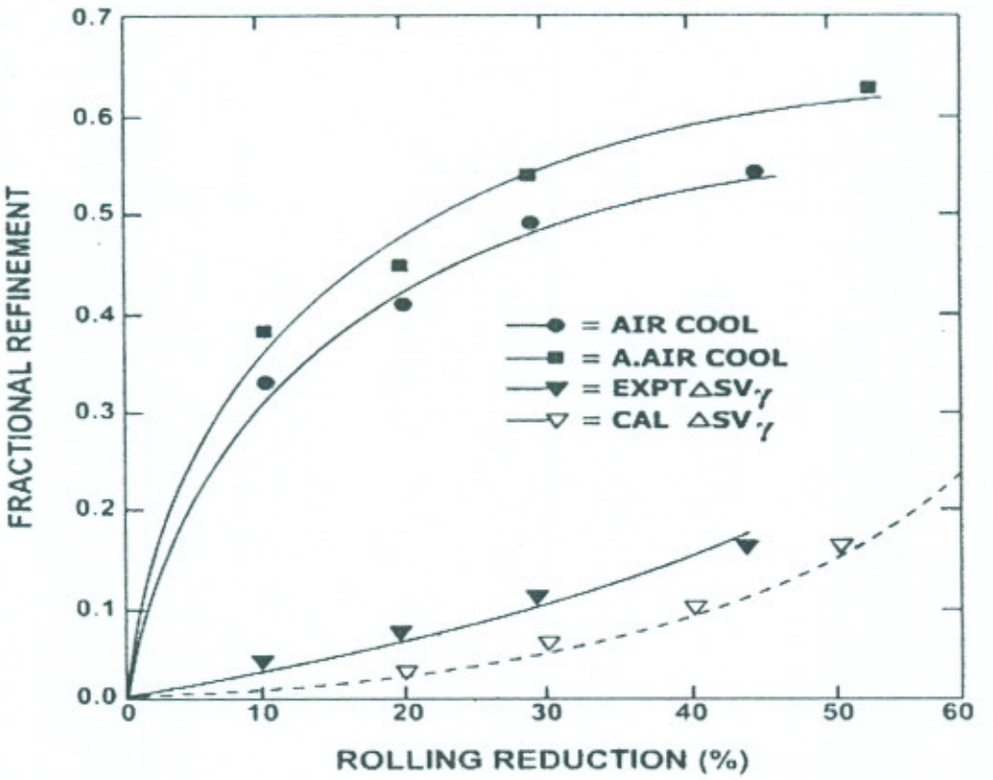


Fig. 3 Fractional refinement of ferrite and austenite grain sizes plotted against reduction for specimens rolled at 850°C

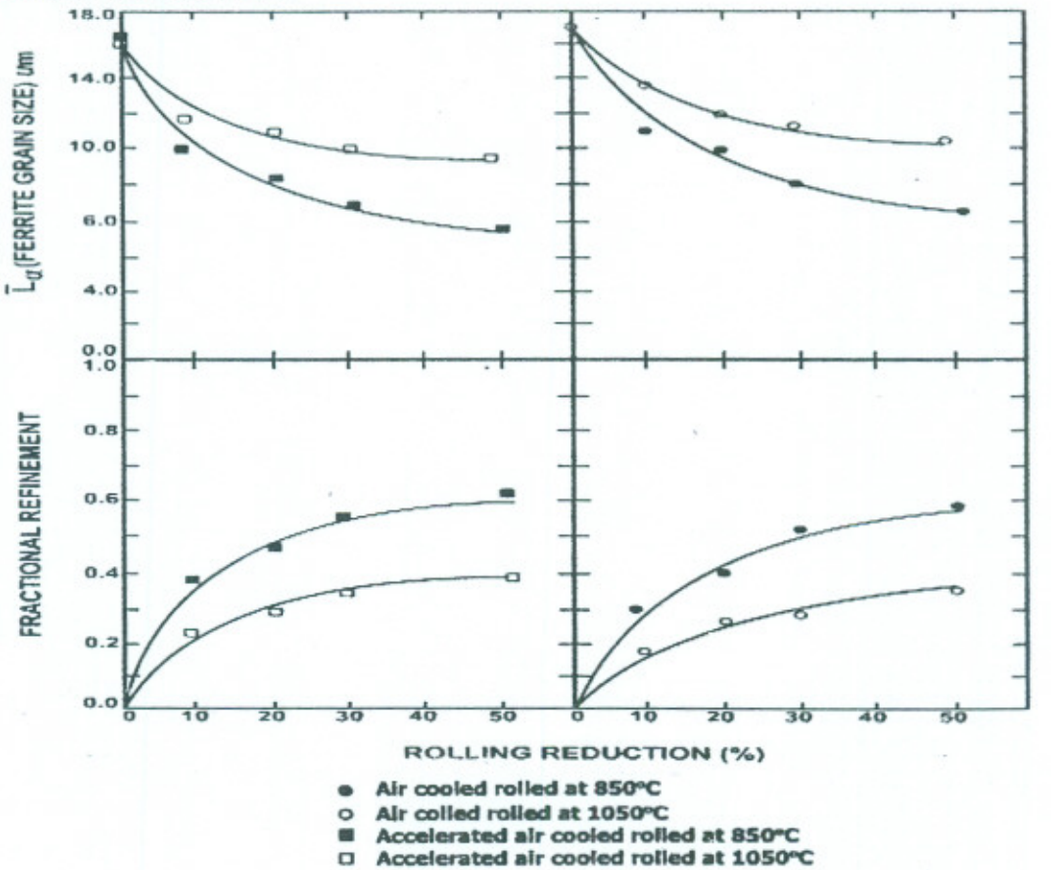


Fig. 4 Comparison of mean linear intercept and fractional refinement of ferrite for steel rolled at 850°C or 1050°C.



Fig. 5 Showing estimated prior austenite grain boundaries (lines on micrograph) in fully transformed specimen, austenitised at 1100°C rolled at 850°C and A.A. Cool.

CONCLUSIONS

1. Ferrite grain refinement was determined by the size of dynamically recrystallised austenite grains, and their rate of growth in the time interval between the end of rolling and the start of transformation.
2. Elongated austenite grains, resulting in a finer ferrite grain size due to an increase in the number of ferrite grains formed per austenite grain. ■

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Report

MOSCOW TRIP REPORT
55TH INTERNATIONAL EXECUTIVE COUNCIL MEETING OF THE ICID INTER-REGIONAL CONFERENCE ON "FOOD PRODUCTION AND WATER : SOCIAL AND ECONOMIC ISSUES OF IRRIGATION AND DRAINAGE"

By

S. M. A. Zaidi * and R. K. Anver *

Nomination of 3 member's delegation from Pakistan Engineering Congress involved a time consuming process of consensus building, with the result that by the time final decision was taken, a very short time was left to complete procedural formalities. These interalia included seeking clearance from RUCID, making arrangements for Foreign Exchange, visa travel and hotel accommodation. Above all, preparation of a meaningful brochure on introduction to Pakistan, as a preamble for ICID conference being hosted by Pakistan in 2008, collection of top class publicity material to be presented at Moscow, was a no small challenge.

But for unrivalled efforts of Syed Mansoob Ali Zaidi, and his hectic exchange of E-mails, faxes and telephones, letters with the relevant agencies, the program could not have been accomplished. Mr. Zaidi's inimitable experience of dealing with such International Conferences coupled with his prodigious energy paved the way to our success in the mission. The following engineers were sponsored by the PEC to represent in the 55th International Executive Council meeting of ICID international conference on "Food Products and Water, Social and Economic issues of irrigation and Drainage".

1. Eng. Syed Mansoob Ali Zaidi
2. Eng. Rana Khursheed Anver
3. Eng. Muhammad Raqib Khan

While at Lahore, despite the short time available, the PEC delegates quickly set on preparation for the forthcoming session of ICID. The goal being that in addition to the usual exchange of technical knowledge and experience, we should endeavor to provide a strong introduction on Pakistan and Pakistan Engineering Congress to the delegates from 140 odd countries. The strategy was to motivate or allure the international community to visit Pakistan in maximum number for the 2008 ICID hosted by PANCID.

Such visits can provide a big boost to our National Economy by unfolding host of opportunities in the field of commerce, trade and industry. Not to talk of any mutual business

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* Former Secretary Irrigation Govt. of Punjab. Presently Secretary Pakistan Engineering Congress.

** Former Secretary Irrigation Govt. of Punjab.

potential, most of the countries were not even aware of our rich cultural heritage and unrivalled natural beauty of the world's highest mountains, the largest glaciers, lakes and passes of our northern areas. Besides they had little knowledge of the largest contiguous irrigation system of the world and Pakistan's untapped potential in other fields. Here the Pakistan Engineering Congress delegates in particular, played a major role and earned appreciation of the International Community one and all.

1. A special bulletin titled "Welcome to Pakistan" was meticulously drafted designed and got printed for distributing amongst ICID delegates in Moscow.

2. Large size attractive posters portraying a series of snow - clad high peaks, large glaciers of the world, high altitude lakes, colors of culture and archeological relic were specially arranged from the Federal Secretary Tourism and culture by PEC delegates for display in Moscow.

3. A 4 hour documentary was also arranged showing Northern Areas, Gilgit, Hunza, Baltistan people with their typical costumes, folkdances, music, sports like Polo, buzkashi. Also the 2nd highest peak of the world K-2, Nagaparbat and the largest glaciers of the world which was on continuous display.

Besides Karakoram highway the Silk route and other features were all impressively portrayed and documented.

Soon after our arrival at Moscow on September 04, 2004 afternoon we hastened to get permission from RUCID and manoeured a stall for exhibiting the captivating pictures and poster of Pakistan. Pakistan's stall was also made a center for distribution of the PEC special bulletin "Welcome to Pakistan".

At the opening session of ICID on September 08, 2004, we specially arranged 12 hours exhibition of documentary on Pakistan on continuous basis. When the delegates attendance was at the peak and their top brass in full glory.

We were lucky to get a slice of 10 minutes to address the audience in the plenary session on 08 September, 2004. Pakistan was the only country which got this special dispensation. A brief address was delivered by Rana Khursheed Anver motivating the audience to visit Pakistan in maximum numbers when Pakistan hosts ICID in 2008, the text of which is reproduced below :

"Mr. Chairman, President Rucid, Honorable Guests, Ladies and Gentlemen.

I am really grateful to the management of RUCID specially Miss Irena Bondarik for allowing me a little slice of time to address this plenary session of ICID. As you all know, Pakistan is hosting ICID in year 2008. Here, I would add that while coming to Pakistan, you would be visiting a fascinating land of scenic contrasts widely varying in its climatic, demographic, physiographic and socio-economic dimensions. I won't elaborate this statement. You would feel the grip as you enter the marble hall and look to the left where a documentary of Pakistan is running.

Pakistan can be divided in three hydrologic basins of which Indus Basin is the largest. It comprises an area of 216,000 square miles, and supports 95% of the country's population. Up in the North, you would find the largest amphitheater of the world formed by the 3 greatest mountain ranges namely, the Himalayas, Hundukush and Karakuram. It is an area where nature exists in its primordial glory and where you could enjoy the magic and mystery of the life. There are high attitude emeralds green lakes like Saif-ul-Maluk. Their dazzling beauty holds you spell bound. The expanse of DeoSai plains (over 80 square miles) sitting at an attitude of 12,000 feet (highest in the world) with the unlimited variety of natural flowers, arranged by mother nature be forgotten by the visitor.

It is here that the mighty Indus rises from some of the world's highest mountains and the largest glaciers and then it traverses through awinspiring and unbelievably deep gorges and Indus plain enroute to the Arabian Sea.

History of irrigation in Pakistan dates back to the times immemorial. With time it developed into the largest contiguous irrigation system of the world, comprising 3 large reservoirs, 20 barrages, 43 canal systems and 44,000 miles of irrigation channels, 6,000 miles of surface drains, 12,000 deep drainage wells and over 6000,000 shallow tubewells in sweet-water zones to supplement the irrigation effort.

We are presently diverting around 106 M.A.F. of River waters for irrigating 35 million acres. Besides, private tubewells are adding another 44 M.A.F. of water for agricultural use annually. Looking to the Worlds Statistics, Pakistan stands 4th in the irrigated area, 5th in drainage and 6th in population.

Here, it may be worthwhile to mention that the entire gigantic net work was mostly designed on the basis of indigenous formulae developed by irrigation engineers of Punjab Province. Some 80 years back, Mr. A. N. Khosa, a Punjab engineer, developed the latest theory for the "design of weirs/barrages on permeable foundations" while Mr. Gerald Lacy, another Punjab Engineer developed a theory for the "design of stable channels in alluvial soils". These formulae later achieved global acclaim and even today are in extensive use in generic or somewhat improved forms. All such theories and designs were developed and projected from the platform of then PUNJAB ENGINEERING CONGRESS and now PAKISTAN ENGINEERING CONGRESS. I would add that even the engineers of 21st century with their innovative techniques don't feel confident unless they crosscheck their results with those from Lacey/Khosla formulae.

Here it may be worthwhile to give a brief Introduction of Pakistan Engineering Congress.

Pakistan Engineering Congress was established in 1912 with the name of Punjab Engineering Congress and on creation of Pakistan, it was renamed as Pakistan Engineering Congress. It is a premier multidisciplinary professional organization with a select membership of about 4,000 practicing engineers. The basic aims and objectives include promotion of engineering profession through annual session, symposium, seminars, lectures and workshops its members a unique platform for discussion and exchange of engineering knowledge and experience. The papers presented at its various technical sessions numbering more than 1,000

have been carefully preserved in chronological order in the archives of Congress. It is a continuous process. The Congress also arranges visits to out stations engineering works at regular intervals for the professional benefit of its members. The quality magazine named as "The Engineering News Journal" provides news, views and technical operation. The Congress has no political, governmental or territorial bias. The Pakistan Engineering Congress is open to international interactions and invites similar information from all over the global to share knowledge and experience with us, under the provision of written M. O. Us. For which we delegates have already received positive indications.

Ladies and Gentlemen at the entrance of the Marble Hall, you would find a high grade display introducing Pakistan in pictures exhibiting the world's highest mountains, largest glaciers and rare archeological relics. We are also running a documentary showing physiographic dimensions and colors of culture in Pakistan. With a short stopover you in the field of adventure and archeological tourism. Nowhere else in the world you would find such a great concentration of high mountains peaks, glaciers, high passes and historic relics.

We promise you a memorable trip to our great country whose hospitality is proverbial.

Finally on behalf of Chairman PANCID, Pakistan Engineering Congress, our delegates and on my own behalf I extend to you heartiest welcome on your visit to Pakistan for the ICID Congress in the year 2008. we keenly look forward to hosting this great event.

Thank you very much for bearing with me for such a long time".

The Pakistan Engineering Congress was introduced and highlighted for the first time in a very clear manner. The speech earned resounding appreciation from the audience. Particularly, delegates from Asia and Africa, specially India were full of praise and excitement when we talked of indigenous formulae of Khosla and Lacy on which the gigantic net work of canal and barrages was designed. It was stated that all these indigenous formulae were developed and sponsored from the platform of Punjab Engineering Congress, now Pakistan Engineering Congress. Even the engineers of 21st century with their state of the art knowledge don't feel confident about their design of hydraulic structures on alluvium soils unless they cross-check with the calculations from Lacey and Khosla formulae.

This speech was very well received and highly appreciated by all, particularly by the Indian delegates and also by the Secretary General ICID. Later the PEC delegates fully participated in the technical sessions and committee meetings and delivered a sound input, which was highly spoken of.

Lastly, we must acknowledge the unstinted cooperation of Mr. I. B. Sheikh, Chairman PANCID who has been very helpful on all occasions. His performance as Team Leader was magnificent.

The Conference was attended by over 500 delegates from 68 countries. ■

INTERNATIONAL CONFERENCE ON ELECTRICAL AND COMPUTER ENGINEERING
INMIC 2004
8TH IEEE INTERNATIONAL MULTITOPIC CONFERENCE
DECEMBER 24 – 26, 2004

National University of Computer and Emerging Sciences – FAST, Lahore

INMIC (IEEE international Multi-topic Conference) is Pakistan's foremost technical conference on the topics relevant to the institution of Electrical and Electronics Engineers Inc. USA, i.e. Electrical/Electronic/Communication/Computer Engineering and Computer Science. It is an annual event in Pakistan in which researchers from academia, industry, and students get together to share their research experiences with each other. INMIC 2004 was the 8th such event in the series and was held at the beautiful campus of the National University of Computer and Emerging Sciences – FAST, Lahore, in collaboration with the IEEE Lahore – Section and the IEEE Computer Society Lahore Chapter on 24 – 26 December, 2004.

INMIC started back in 1996 as a national IEEE conference and is becoming a popular event year by year. With the passage of time the international participation has increased. This year it is further internationalized by the fact that out of 445 papers, 129 were submitted from 22 foreign countries : Australia, Bangladesh, China, India, Malaysia, USA, UK, Iran, Germany, Denmark, Austria, France, Japan, Korea, Canada, Oman, Saudi Arabia, Sweden, Switzerland, Tajikistan, Thailand and UAE. Also this year there were more reviewers from foreign countries.

This year, the numbers of received papers were 3 to 4 times the number of papers submitted in any previous INMIC. The Programme Committee worked hard along with the reviewers from all over the world to select 122 papers out of 445 for presentation and publication in the proceedings of the conference. The review was a double blind process that spanned over a period of three months. Out of 1220 papers selected for presentation in the conference that have also been published in the proceedings, 79 were from Pakistan and the rest 43 were from 17 foreign countries.

The conference programme consisted of one day of tutorials and two days of presentations of research papers. There were seven tutorials that were presented on Friday 24th by experts from Japan, USA, Austria, Saudi Arabia and Pakistan. The tutorials were presented in two parallel sessions. The main focus of this conference was on research papers. 122 research paper presentations were arranged in four parallel sessions on 25th and 26th December. The selected papers covered various fields of engineering and science, speech, Image and Video Processing, Digital Signal Processing, Communication Systems, Computer Networking, Artificial Intelligence, and Software Engineering are a few of them. Conference proceedings have been published in a 750 pages volume with an ISBN Number, Library of Congress Catalog Number, and IEEE Catalog Number. These research papers will soon be available on Internet from all over the world through the IEEE Digital Library.

It took a total of three years stating from the initial planning phase and about one and a half year in the active organization of the conference. Call for a paper was announced in November 2003. Seven months were given to authors for the submission of papers, and three months to reviewers for selecting papers based on originality and quality. A month and a half was again given to the authors of the accepted papers for camera ready submission, and a month and a half to the publication committee to get the proceedings published before the conference in December 2004.

Dr. Amir Muhammed, Rector, National University of Computer and Emerging Sciences was the Chief Guest in the Inauguration Ceremony on the morning of 24th December 2004.

Engr. Dr. Syed Amjad Hussain Shah, Senior Member IEEE and Conference Chairman, Engr. Sajid Aziz, Senior Member IEEE and Chairman IEEE Lahore Section, and Engr. Dr. Muhammad Ayub Alvi, Dean FAST – NU, also addressed the Inauguration Ceremony.

Senator Waseem Sajjad, who is also President of the FAST Board of Governors, was the Chief Guest at the Conference Dinner. He awarded shield to the Tutorial Presenters and to the Organizing Committee of INMIC 2004. The tutorial presenters were Prof. Dr. Eiho Shigeru from Japan, Dr. Junaid Mughal from GIKI Pakistan, Prof. Dr. Asrar Sheikh from Saudi Arabia, Dr. Andreas Daniel Matt from Austria, Mr. Naeem Hashmi from USA, Dr. Khurshid Qureshi from USA, and Engr. Ahsan Abdullah from FAST – NU, Islamabad.

The names of the members of the Organizing Committee, who received shields from the Chief Guest Senator Waseem Sajjad are : (1) Conference Chairman Engr. Dr. Syed Amjad Hussain Shah, Senior Member IEEE, (2) Conference Co-Chair Engr. Dr. Qaiser S. Durrani, Member IEEE, (3) Chair Steering Committee Engr. Dr. Fakhar-ul-Islam Lodhi, Member IEEE, (4) Co-Chair Steering Committee Engr. Abdul Aziz, Senior Member IEEE, (5) Chair Technical Committee Engr. Dr. Arshad Hussain, Member IEEE, (6) Chair Publication Committee Engr. Dr. Sarmad Hussain, (7) Chair Finance Committee Engr. Belal Muhammad Hashmi, (8) Co-Chair Finance Committee Engr. Husnain Reza Mirza, Senior Member IEEE, (9) Member Organizing Committee Ms Tahreem Fatima Hasani, (10) Member Organizing Committee Mr. Amir Wali, (11) Member Organizing Committee Engr. Farrah Fayyaz. In addition to these the shields were also awarded to three students who activity participated in the Organization of the conference, their names are : Numan Saeed Anwar, Adnan Umer and Irfan Ahmed. A team of more than 70 students helped during the conference who will be given certificates and souvenirs in the Annual Dinner of FAST – NU, IEEE student Branch by the end of January.

Conference Chair Engr. Dr. Syed Amjad Hussain Shah, Senior Member IEEE and Director FAST – NU, Lahore Engr. Dr. Qaiser S. Durrani, Member IEEE also addressed the Dinner participants.

The paper titled "Fusion of Optimized Moment Based and Gabor Textile Features for Better Texture Classification" authored by Naeem Qaiser, Mutawara Hussain, Nadeem Qaiser, Amir Hanif, S. M. J. Rizvi and A. Jalil was given the best paper award.

The conference was intended to provide a forum of international standard with minimum costs to Pakistani researcher/scholars to share their research with each other. Over the years INMIC has been instrumental in promoting the research culture in Pakistan. We hope that INMIC 2004 would have helped in continuing this rich tradition and will go a long way in the advancement of research activity in Pakistan. About 250 authors and delegates from Pakistan and abroad participated in the three day conference which was a very successful event. ■

For further details and more information you may contact.

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Copy of Proceedings available in Pakistan Engineering Congress Library.

Opinion

POLLUTER PAYS PRINCIPLE

Mian Iftikhar Ahmad, *Water, Sanitation and Environmental Consultant.*

One of the core principles of sustainable environment is the "Polluter Pays" Principle. This recognises that the polluter should pay for any environmental damage done, and that the burden of proof in demonstrating that a particular technology, practice or product is safe should lie with the developer, not the general public. Unfortunately, when and how much the polluter should pay is often unclear.

One way to adequately implement "the polluter pays principle" in the real world makes use of what are known as assurance bonds (such as Defence Saving Certificates). Money put up by the "polluter" to insure against a worst case scenario. The bond would be recovered only if after sufficient time it had been demonstrated that the technology, process or product in question had been deemed to be safe as was reasonably acceptable. Alternatively, if damage occurred, the bond would be used for environmental restoration and to pay damages to anyone who had been harmed. By allowing the bond to accrue interest/profit, the "polluter" receives an incentive to ensure that best environmental practice is followed, and to demonstrate that the technology, process or product is as safe as practicably possible, without involving excessive cost. ■

OBITUARY

May their souls rest in Peace

1. Engr. Mian Bashir Ahmed, Former Chief Engineer Irrigation Department Govt. of Punjab passed away on 20.12.2004
2. Engr. Muhammad Rashid Vohra (Retd.) C. E. (C & W) Department Govt. of Punjab.
3. Prof. (Retd.) Khalifa Saeed-ud-Din Former Prof. of Department of Civil Engineering, U.E.T. Lahore, passed away on 31.12.2004.
4. Rimsha daughter of Muhammad Fiaz assistant of the P. E. C. office.

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