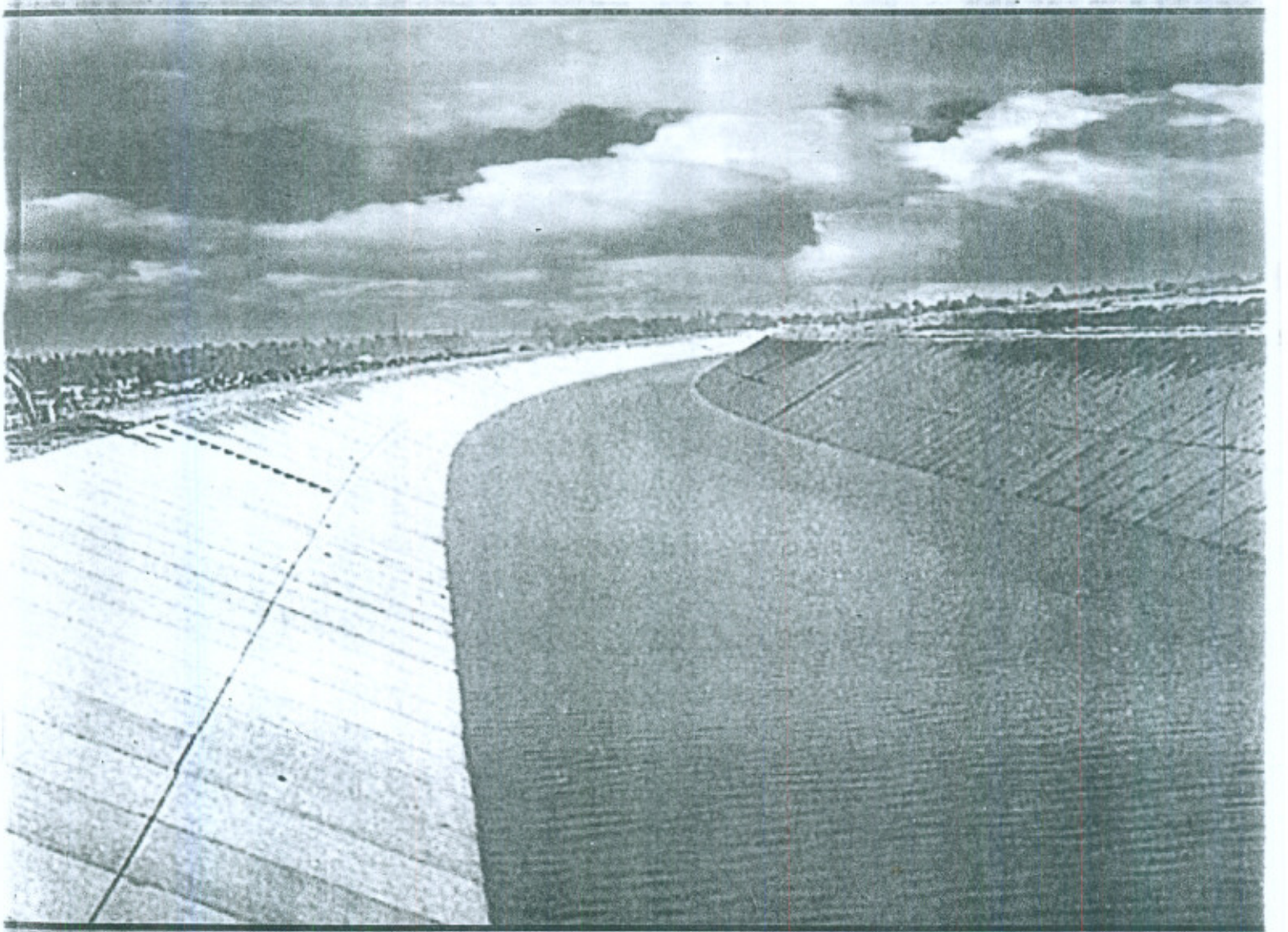
Engineering News

A Quarterly Journal of the Pakistan Engineering Congress

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46th YEAR OF PUBLICATION

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Vol. 42 July - September 2004 No. 2

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EDITORIAL

ENVIRONMENTAL IMPACT ANALYSIS BENEFITS ALL

Essence of environmental and socio-economic analyses of a project," its acceptability by the public and benefits of such facilities reaching the masses, depends upon the amount of efforts made by the entrepreneurs to analyse the user needs, its socio-economic and environ-mental impacts. It equally applies to new development projects, as well as to dismantling or modification works. In question is the destruction of a large number of bridges over Lahore Canal which had been undertaken without any reasonable analysis, information to or consultation with the public. Impact of dismantling canal bridges is manifold. Commuters who could take U-turn at the relevant places are now forced to cover long distances to get access to the roadways leading to their destinations are confronted with wastage of time and money. A large number of communities existing on the North and South of the canal have been served and deprived of easy access. This adds mental irritation and fatigue which may enhance chances of accidents to the road users as well as residents of the communities. Long journey times with increased emissions add to air pollution which will effect the quality of life in the area.

The bridges are built to provide easy linkage and to mitigate severance impacts where the property is divided and bisected by the roads, railways and buildings of canals. To destroy them is to deprive public of the close contact of the communities around. Merits and demerits of any project can be established through the social, economic and environmental impact analyses or in some cases by initial examination. Government of Pakistan has promulgated environmental protection laws and environmental impact analysis (EIA) is an important and integral part of the application of the law and must be followed in letter and spirit. The environmental impact analysis provides for public hearing giving a chance to the stake holders to voice their concerns over the project utility an important step towards enhancing public acceptance of the project. Another important requirement of project planning is the participatory approach. For example large number of water supply systems could not yield the optimum benefits because the users were not consulted prior to planning, at the time of construction and during their operation. Even some of the overhead bridges built in the city of Lahore at the busy road crossings could not get public acceptance.

In the aided projects strict standards are applied for project analysis and that should also be followed by the Government Planning Agencies. Rehabilitation by NHA of N-5-National Highway is a shining example of appropriate analysis.

Environmental impact analysis need not be considered just a legal formality or an intention to keep the environmentalists quiet. It must rather be a planning tool to fully analyse the prevailing and future environmental conditions so intimately related to the comfort, health and well being of the posterity. Last but not the least the engineering community appreciates the Government of Punjab's efforts to mitigate the impact of broken bridges by providing suitable overhead bridges and under-passes, belated but not too late.

News

WHO REVISED WATER GUIDELINES – THIRD EDITION (2003) ISSUED

The new edition of WHO's Guidelines for Drinking water Quality provides a state of the art perspective on issues of water quality, health and on effective approaches to water safety management.

The Guidelines are used by countries world-wide as a scientific basis for standard setting and regulation and are used extensively by professionals and local decision makers. They supersede two editions of guidelines of previous International Standards.

The fully revised third edition includes expanded coverage on systematic drinking water safety assessment and management. It describes a "Water Safety Framework" encompassing complementary functions of national regulators, water suppliers and independent surveillance agencies. The "Water Safety Plan" provides a comprehensive approach to assist suppliers in water safety management.

Guideline Values for individual chemicals have been reviewed, updated and newly added in response to available scientific information. Summary statements are included for specific pathogens and individual chemical hazards of actual or potential concern.

The third edition also includes more information on application of the Guidelines in specific circumstances (e.g. small community supplies, in large buildings, in emergencies and disasters) ; and to specific applications (e.g. bottled water).

Source : World Health Organization (www.who.org)

PAKISTAN ENGINEERING CONGRESS CONTRIBUTION IN ADVANCEMENT OF ENGINEERING EDUCATION

Pakistan Engineering Congress took a historic step of Instituting Eight (8) Nos. Scholarships for Post-Graduate Studies in 69th Session. In the current 70th Session, the number of these scholarships has been raised to Sixteen (16) Nos. as mentioned below :

- University of Engineering and Technology, Lahore 6
- N.W.F.P. University of Engineering and Technology, Peshawar 2
- University of Engineering and Technology, Taxila 2
- N.E.D. University of Engineering and Technology, Karachi 2
- Mehran University of Engineering and Technology, Jamshoro 2
- Balochistan University of Engineering and Technology, Khuzdar 2

The Vice Chancellors of the above universities have been informed alongwith criteria for awarding scholarships which is as under :

(i) They should be regular and enrolled students of Engineering Universities having recognition of its degrees by Pakistan Engineering Council.

(ii) They should be students of Post-Graduate studies in engineering subject.

(iii) They should have secured 70% or above marks.

(iv) They should not be more than 35 years of age on 30th October, 2004.

The applications should be routed through the respective Universities and are to be accompanied by the following documents.

- Attested copies of Matriculation and Intermediate Certificates
- Attested Copies of B.Sc. Engineering Degree with detailed marks sheet for each year (duly attested)
- Income of self and parents
- Proof of age

Proposal to institute scholarships for under graduate studies is also under consideration.

WATER SOURCE PROTECTION

By

Engr. Sajjad Haydar*

1. INTRODUCTION

A community water supply can be generally divided into four components.

- Source
- Treatment works
- Transmission works
- Distribution works

Source holds an important position in community water supply systems. Selection of a source is based upon two criteria.

- Quantity of water
- Quality of water

i.e., a good source must the qualitative as well as quantitative requirements. Once the quality of water is found satisfactory, its ascertained to meet the present and future demand.

The prevention of water contamination is always preferable to attempting to remove contamination once it has entered the aquatic environment. In this connection source protection can act as the first line of defence. Whilst it is likely that some contamination events will always occur, a large proportion of drinking-water quality problems can be prevented through: adequate source protection and good water resource management; good design; proper operation and management of water supplies; and regular and thorough surveillance activities. Although the technologies exist to purify contaminated water so that it can be consumed by humans, total reliance upon technological solutions appears to be unacceptable for a number of reasons including: high costs of using advanced treatment methods; lack of technological sophistication among many of the nation's municipal water supply systems; and potential health hazards from new synthetic organic compounds.

The initial selection of a source of drinking-water should ensure that the best source is selected. This can be done by carrying out a thorough analysis of source water quality and making a comprehensive assessment of the vulnerability of the source to contamination. This should obviously be done before any investment is made in construction.

The quality of the proposed source water should be tested under 'worst case' conditions (those periods when contamination is most likely to occur such as the start of a wet period or when ground water levels rise). A sanitary inspection and pollution vulnerability assessment of the source should also be undertaken under 'worst case' conditions.

A sanitary inspection should indicate the risk to the source from sources of microbiological contamination in the immediate surroundings of the source and suggest measures that may be taken to protect the source from continued contamination. A pollution vulnerability assessment will provide information on the risk to the source of contamination from a wider perspective and identify potential risk from chemical contamination. Sanitary inspection and vulnerability include on-site inspection and evaluation of potential sources of pollution with respect to their present and future importance.

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*Assistant Professor, Institute of Environmental Engineering & Research, UET, Lahore

Sometimes, a contaminated source may be used owing to the absence of any other cost effective and reliable source in the vicinity. Under such circumstances, evaluation of the nature of contaminants present and the type of treatment to mitigate potential health hazards be carried out.

2. WATER SOURCE PROTECTION

i) Evolution of Water Source Protection

The quest for pure, clean drinking water began in prehistoric times. However, scientific evidence linking public health to water supplies was not available until the mid-nineteenth century. Dr. John Snow, in 1854 established for the first time a link between high incidence of cholera in a community of London and its highly polluted water source, i.e. River Thames.

Early measures for source protection included: isolation and shifting of water sources beyond the urbanized areas, land acquisition around a water source, prohibition of public access etc. However with the advent of water treatment technologies in the latter two decades of the 19^{th} century and first decade of 20^{th} century, the use of above said methods steadily diminished. Thus, over the time the "first line of defence" became no line at all.

It was only after 1970, that the consequences of shunning the practice of source isolation was felt and it was recognized that water treatment could not be a substitute to the protection of water sources. Now-a-days, source protection is an important component of overall water quality planning and management.

ii) Drinking Water Contaminants

Table 1 presents a list of water contaminants and their effects.

Table 1: List of Water Contaminants and their Effects

Sr. No.	Contaminant	Examples	Effects
1.	Microbiological Life	Bacteria, viruses protozoa, fungi, algae	Health effects, taste and odour.
2.	Solid particles in suspension	Clay, organic and inorganic particles	Turbidity, carriers. Effect storage capacity of reservoirs
3.	Inorganic solutes	Heavy metals and other inorganics (arsenic, fluoride nitrate, sulphates, etc.)	Health Effects
4.	Organic solutes	Pesticides, synthetic organic compounds (CCl_4, benzene etc). 423 found in water and 325 in treated water.	Carcinogenic
5.	Radioactivity	Various radioactives.	Damage to genes, cells, off-springs.

(Source : After Burby and Kaiser, 1983)

Consumption of polluted water may result in acute or chronic health effects. Acute effects occur suddenly, soon after a person is exposed to microbiological contamination or toxic levels of chemicals. In most cases, it is possible to recover from acute effects of drinking polluted water if medical treatment is received promptly. On the other hand, chronic effects are frequently irreversible. They are normally associated with toxic compounds that accumulate in the body over long period of time, eventually reaching concentrations that will cause cancer or other types of illness. It may take 20 to 30 years for chronic effects, of drinking contaminated water, to occur.

(iii) Water Source Protection?

Water source protection is a mixture of localized measures designed to protect individual sources and wider ranging measures designed to protect the larger water resource body. The latter can be on a provincial, national or regional (international) basis. For surface waters, the most appropriate level to protect water sources is through basin management. Depending on the size of the catchment area and water body, this may mean working on a scale ranging from district or provincial level up to international treaties involving several riparian countries (for instance the Nile and Zambezi basins).

Surface water sources and resources are far more open to contamination and potential catchment areas of contamination are generally far larger than for groundwater. Thus, any measures taken to protect surface water resources will generally encompass a far wider geographical region than measures designed to protect groundwater resources.

It is important that both localized and wider measures are undertaken to protect sources used for drinking-water supplies. Local measures are required to ensure that the actual water source is not at risk from contamination in its immediate environment. An example of this is a wellhead completion measures on the top of boreholes, which ensure that the top of the borehole is sealed against the entry of contaminated surface water. Large-scale measures are required to ensure that valuable water sources are not lost because of contamination of the water body some distance away from the drinking-water source. An example of this is the definition of land-use zones around important aquifers to limit potential contamination.

3. GROUND WATER PROTECTION

Groundwater is an important source of drinking-water in Pakistan. Various methods for the extraction of ground water include:

- Springs
- Hand pumps
- Shallow wells.
- Tube wells.

(i) Localized Measures

Localized measures vary with the method of extraction and are discussed as under:

Springs: Localized protection for springs include construction of "Spring Boxes" and "Diversion ditches" to prevent surface water run-off from entering the spring box (Figs. 1, 2)

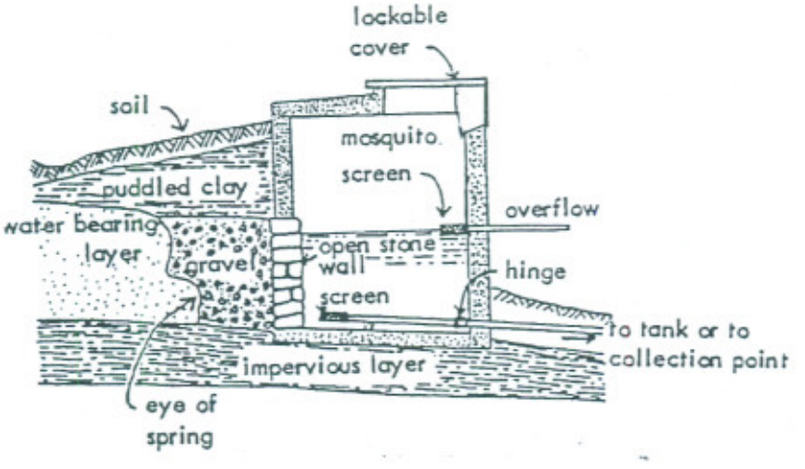


Fig. 1: Typical Diagram of Spring Box.
(Source: Cairncross and Feachem, 1978)

Hand Pumps/Shallow Wells: Localized protection on the first instance includes careful location of these sources away from sources of contamination as pit-latrines and soakage pits. Secondly, a proper well-head protection be provided at the top of

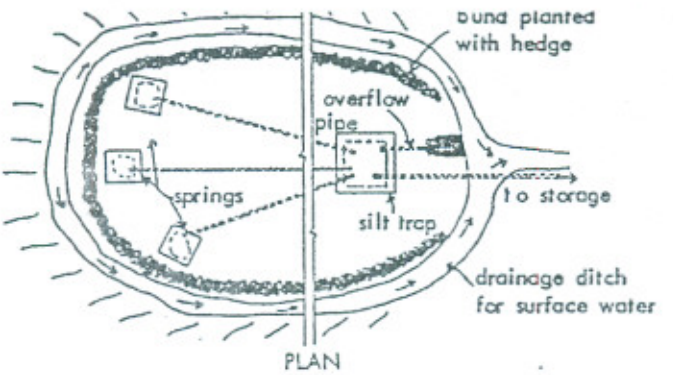


Fig. 2: Arial View of Diversion Ditch and Hedge.

(Source: Cairncross and Feachem, 1978)

boreholes to avoid entry of contaminated surface water and water spills (IRC, 1981). Shallow well should be properly covered and be provided with a concrete or brick apron slopping away from the well (Fig. 4 & 5).

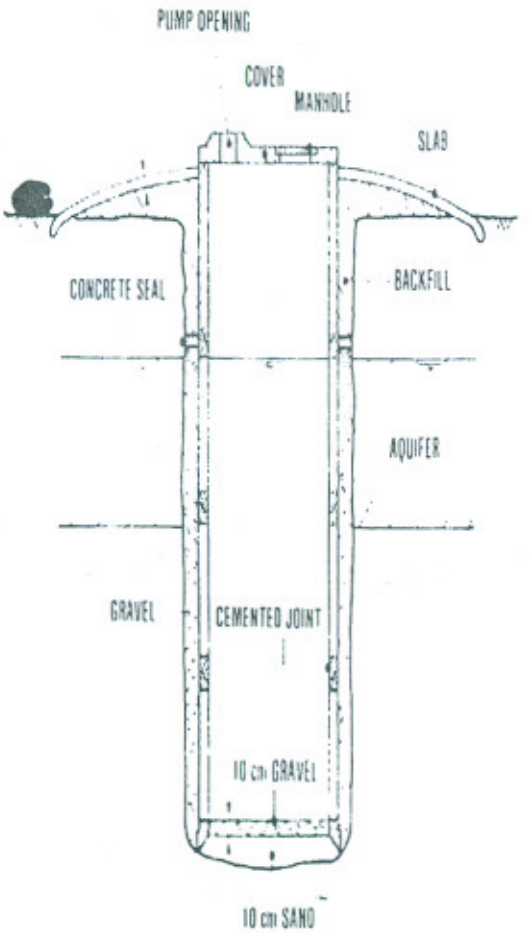


Fig. 4: Well-head Protection Arrangements.
(Source: IRC, 1981)

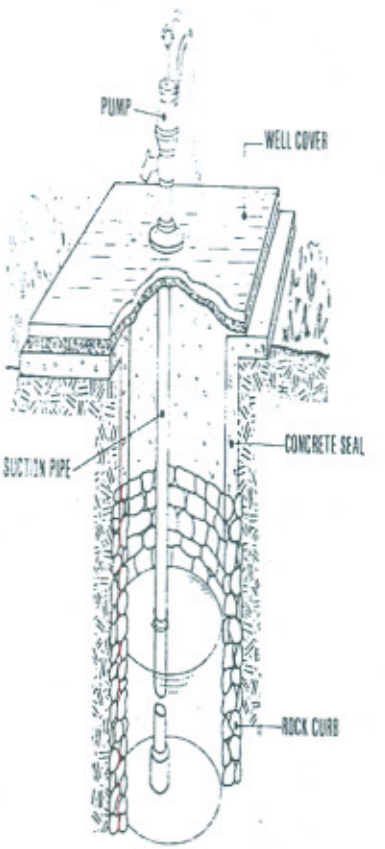


Fig. 5: Safe Withdrawal Method from Shallow Well.
(Source: IRC, 1981)

Tube Wells: For tube wells, localized measures include the provision of a sanitary seal. It is filling the upper 30 m with 1:2 cement sand mortar or clay slurry to prevent penetration of contaminated water along the tube well bore (Fig. 6).

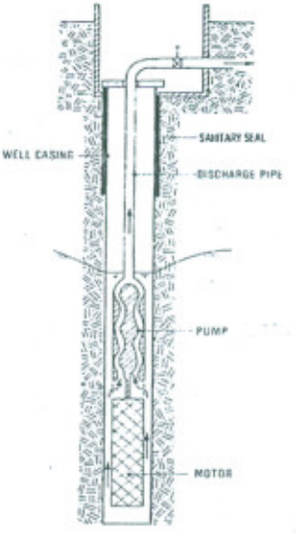


Fig. 6: Tube Well Protection with Sanitary Seal
(Source: IRC, 1981)

(ii) Broader Measures

Broader measures include all the steps taken for the protection of groundwater aquifer from where the water is drawn using different methods.

In its natural state, groundwater is generally of high microbiological quality with little or no contamination, although some groundwaters do have high levels of harmful chemicals such as fluoride and arsenic. The relative purity of groundwater in its natural state is largely a result of infiltration through the soil and unsaturated layers of rock. During infiltration attenuative processes such as sorption, mechanical filtration and ion exchange operate, which remove bacteria and some chemicals, particularly metals, from the water. However, some chemical compounds, such as nitrate, are not easily attenuated and once in the sub-surface aquatic environment are highly persistent and mobile. It is thus important that such chemicals arc prevented from entering aquatic systems.

Once an aquifer is contaminated, as the movement of water through sub-surface systems relative to their volume is slow and residence times are lengthy, the natural processes of removal by dilution and discharge to surface waters may be extremely long (decades, centuries or millennium). Thus prevention of contamination of groundwaters by persistent mobile contaminants is an essential element in the protection of groundwater resources. A further complication is that many attenuative processes in the saturated zone are reversible and whilst initially contaminants may be removed from solution through, for instance sorption, at a later date they may be desorbed and re-enter the water. This is a common problem in industrial cities in western Europe, where initial development led to a decrease in the water and subsequent attenuation of contaminants in the unsaturated zone. Subsequent development has occurred elsewhere using different water sources leading to a recovery of groundwater levels and desorption of contaminants and groundwater pollution. For instance there has been a noticeable increase in the levels of heavy metals in recovering groundwaters beneath London.

Different types of aquifers are vulnerable to contamination to differing degrees. Generally where aquifers are overlain by a substantial unsaturated zone and have high primary porosity and reasonable permeability, they tend to be less vulnerable to pollution. Aquifers where water is primarily held in secondary porosity (fissures and joints) tend to be more

vulnerable to contamination as the water has less opportunity to undergo attenuative processes, which remove contaminants.

This has led to the concept of "Groundwater Protection Zones" where acceptable land uses are defined in order to protect the underlying groundwater. Those zones were originally developed in Western Europe, particularly Germany and the Netherlands, to prevent contamination of groundwater supplies by pathogens and thus reduce the incidence of water borne diarrhoeal diseases. The boundaries of groundwater protection zone are determined according to isochron concept. The isochron is a line of identical flow time. This concept determines the boundary and geometry of a protection zone in pure hydraulic terms. The delineation of groundwater protection zones is done by establishing the length of time a substance or organism takes to become non-harmful and the distance this represents under groundwater flow conditions.

Microbiological groundwater protection zone are established on the basis that the vast majority of pathogenic bacteria die off within 50 days of being in groundwater under normal conditions. Thus by establishing the distance travelled by groundwater in 50 days for a particular area, a zone can be defined from the abstraction point.

The definition of zones for chemical protection has also been attempted but this has been far less successful than the delineation of microbiological zones. This is because, unlike microbiological survival rates, it has proved extremely difficult to establish or even estimate the half-life of many chemicals in groundwater. Not only is there a vast number of chemical compounds which may be found in water, but groundwater and aquifers (particularly hard rock aquifers) frequently have a complicated chemistry themselves which may interact with pollutants and extend or reduce half-life. A 500-day isochron (Fig. 7) has been suggested in some quarters as being sufficient, but in reality far more work is needed in this area and chemical persistence will vary with different chemicals and aquifers.

Groundwater Protection Zones may take many shapes. They are very rarely simple circles drawn with an abstraction point as the centre (Fig. 7). There are many factors which will influence the shape of the zone: the nature of the aquifer (which are very rarely isotropic); the number of rivers in the zone; the condition of rivers (whether influent, effluent, perched or changing); and the number and location of other abstraction points within the zone.

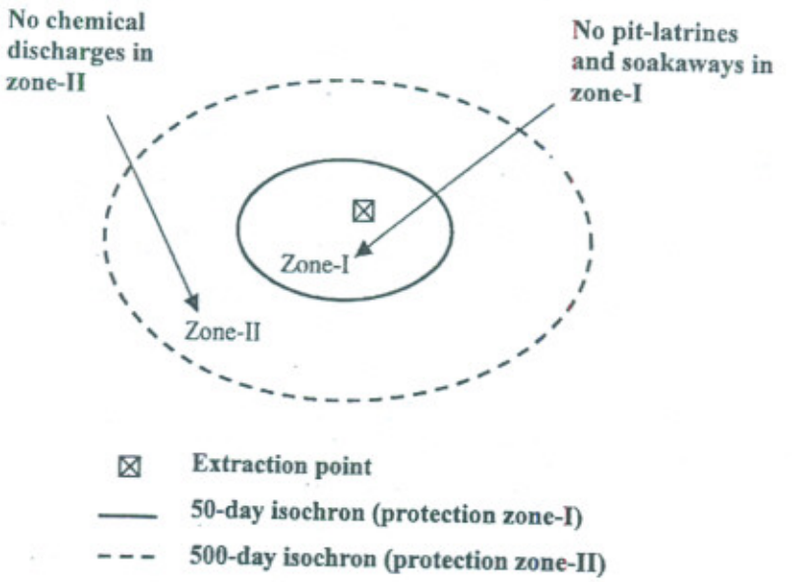


Fig. 7: Concept of Groundwater Protection Zones

(Source: Berlin Digital Environmental Atlas, 2004)

Surface waters that overlie an aquifer will extend the zone along its course upstream, as contaminants are likely to move more quickly in surface water. It is important to establish what relationship the river bears to the aquifer, as obviously where a river is supplied by the aquifer, the protection zone need not be as extended as when the river recharges the aquifer. However, it is always likely that a river will be influent to an aquifer at some point along its course. Even under effluent conditions there will be river-groundwater interaction and the extension of a zone some way along river, which is recharged by the aquifer is always recommended. The more the river associated with the aquifer, the greater the distortion and extension of the zone.

Within the protection zone, land use may be restricted to non-polluting activities and ensure that any discharges within the zone meet stringent quality standards. This may be problematic where there is intensive agriculture with widespread use of inorganic fertilizers and pesticides. In these cases, permitted application loads may be introduced and groundwater quality monitored. In these circumstances it is often found that producers can reduce applications whilst maintaining yields, although it is possible that some form of compensation for loss of production may have to be provided. Where intensive animal production is practised, adequate isolation and treatment of slurries should be carried out by the farmer and leakage to groundwater minimized.

4. SURFACE WATER PROTECTION

Surface waters are particularly vulnerable to contamination from agricultural, industrial and municipal sources. Surface water bodies receive wastewater from industrial and municipal sources, agro-chemicals may leach into them, air-borne pollutants may dissolve in surface water and they receive overland run-off that washes surface debris. As a result, all surface waters require treatment before they are supplied for drinking water, whether the source is a river, lake or reservoir.

There are a number of interventions which will help to protect the quality of surface waters, principal amongst these are: land-use control within the catchments; and proper siting of intake structures away from potential sources of pollution and preferably upstream of them; treatment of effluent and discharges leaving industrial plants and municipal sewage treatment works, and; the establishment and enforcement of effluent quality standards.

Where surface water is used as a source of drinking-water, it is appropriate to ensure that land use within the catchments is controlled and preferably limited to activities which are relatively non-polluting. This can be problematic as some activities may already be established which do cause pollution and in these cases, adequate standards of effluent quality should be established and enforced.

Land-use control has tended to be more effective when applied to artificial reservoirs, principally because in many countries these have been located away from intensive human activity. However, land-use controls may be difficult to introduce as the creation of a large body of water may attract industry, which will have effluent discharges. Reservoirs may promote intensive arable agriculture, which utilizes inorganic fertilizers, and pesticides, which may pollute the reservoir.

In many countries, standards have been or are being developed and enforced governing the quality of effluent that may be discharged into a river or standing body of water. In many countries, national bodies concerned with water are trying to shift the onus onto producers to treat wastewater prior to discharge - the 'polluter pays' principle. However, few countries have managed to enforce compliance with these standards and large-scale pollution continues. In many countries the penalties for exceeding quality standards are minimal and as the cost of installing treatment plant greatly exceeds the accumulated cost of fines, there is little incentive for the producer to invest in treatment technology. This situation is often exacerbated by the time it takes for cases involving pollution to reach court, further reducing the real cost to the producer.

The rigorous enforcement of compliance with effluent quality standards backed up with adequate legislation, which has penalties, which reflect the severity of the pollution event will make a significant contribution to the improvement in surface water quality. However, positive influence should also be exerted to assist industry to employ discharge treatment in their plants. This may include awareness raising in the industrial sector, technical advice concerning technology choice and may also involve other incentives to industry, such as tax breaks or subsidies, to promote the use of treatment of effluents.

Sediments in surface waters also interact with pollutants in the aquatic environment and can become "reservoirs" of pollution. Where chemical contaminants, particularly metals, are in water there are commonly ion exchange reactions with minerals in the sediment and diffusion of chemicals into the sediment, which leads to contaminant build-up. Where there is significant organic material in sediments on the base of streams, metals form organic complexes. These processes may remove contaminants from the water in the short-term, but may be released back into the aquatic environment at a later date, usually in response to a specific flood event. Thus stopping a polluting activity will not lead automatically to a rapid reduction in contaminant concentration in surface waters.

5. CONCLUSIONS

Water source and water resources protection are essential if high quality waters are to remain uncontaminated. Both groundwaters and surface waters are vulnerable to pollution and both require localized and larger-scale actions to prevent pollution of drinking-water sources. Surface waters are open to more immediate pollution and once a pollutant enters a surface water body, it is likely to move rapidly. This means that the pollutant will spread rapidly through the surface aquatic system, although it may make remediation easier, except where there is significant water-sediment interchange.

Groundwater has more natural defences against pollution, however once it becomes polluted it is very difficult to remove the pollutant from the groundwater system and residence time of pollutants may be decades, centuries or longer. Different types of aquifer have differing degree of vulnerability and thus have different protection requirements.

Both surface and groundwater resources can be protected by defining land-use zones around them. This ensures that the establishment of potentially polluting activities is not allowed within a distance that would allow easy pollutant movement. Control of pollution is vital for water source and water resource protection and should be rigorously enforced.

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CASE STUDY IN FACILITY LAYOUT REDESIGN

BY

Engr. Imran Hasan and Tauseef Aized*

ABSTRACT

This paper shows how improvements can be made in the performance and productivity of a manufacturing facility by improving its layout. Facilities planning principles are applied to an existing facility, and a new layout is obtained that provides better workflow and results in greater productivity.

HISTORY

Facility layout and location problems have been the subject of analysis for centuries. One of the earliest known examples of the scientific use of facility layout and location methods datès back to the seventeenth century. The emergence of management science and operations management has led to a more focused and intense approach towards facilities planning and design.

The facility layout problem is one that encompasses both quantitative as well as qualitative issues. The handling of both these issues in conjunction is not an easy exercise. Rosenblatt [1], Rosenblatt and Sinuany-Stern [2] employ a very efficient approach around this problem. Montreuil and Ratcliff [3, 4] unified a vast amount of plant layout algorithms including REL diagrams and space relationship diagrams, both of which are utilized in this work. A number of graphical methods have also been identified by Muther [5], Carrie et al. [6] and Tompkins & White [7].

The role of computers is also becoming increasingly important in facility layout design. One of the earliest works utilizing computers in facility layout planning was that of Moore [8]. For a more detailed look into the computerization opportunities is recommended by Hales [9].

INTRODUCTION

Productivity is normally defined as the output achieved with respect to a given level of input. There are various ways of increasing the productivity of a system, which revolve around manipulation of inputs and outputs. It is normally assumed that radical changes such as new process development, production machinery and technology needs to be incorporated in order to improve productivity.

One of the simplest method's of improving productivity that is generally overlooked is to focus on the design of the layout of the manufacturing system. Usually, in manufacturing systems where processing takes place in batches, machines are laid out in random fashion with little importance being given to the flow of work and information between workstations. This, however, results in time being wasted in the transfer of work between stations and the buildup of work in process inventory.

This case study takes into consideration Ms. ABC, an existing manufacturing facility in the vicinity of Lahore (whose name has been kept confidential for privacy reasons), and proposes a redesign of its layout for improving productivity.

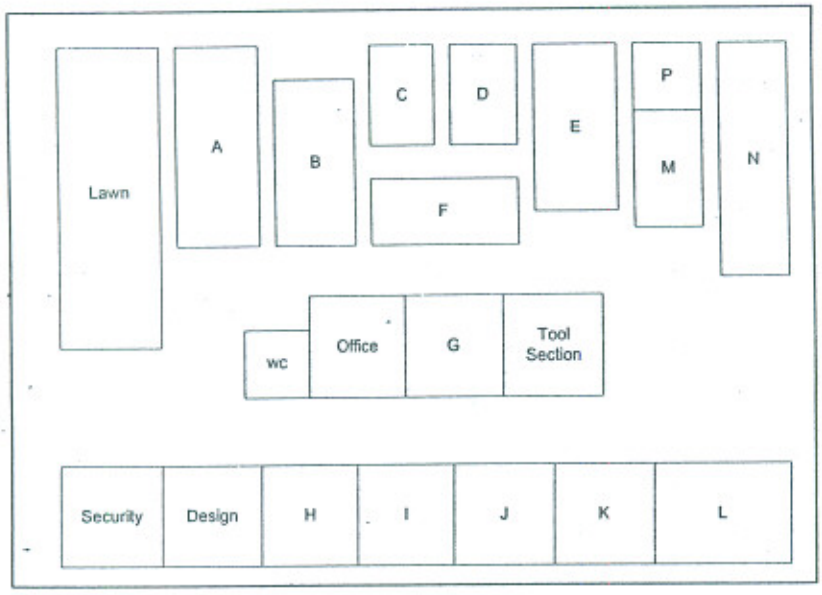
DATA COLLECTION

M/s. ABC is a metal manufacturing facility located on the outskirts of Lahore, Pakistan.

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They produce different kinds of metal products, a majority of which are used in the assembly of tractors. To produce such a large range of parts, different types of machines and processes are utilized. Information gathered from the facility showed that they have 14 different departments including foundry, heat treatment and machining departments having conventional lathe machines and CNC machines. Figure 1 illustrates the existing layout of the facility.



A – CNC Lathes
B – Milling
C – Grinding
D – Milling II
E – Lathes
F – Fitting
G – Inspection
H – Welding
I – Induction Hardening
J – Electroplating
K – Heat Treatment
L – Sand Blasting
M – Machine Shop
N – Foundry
P – Hydraulic Testing

Figure 1. Existing Layout of Facility

Once basic information has been gathered, it is possible to analyze the flow of materials, equipment and personnel. However, as the primary consideration in this particular case is production, therefore the emphasis is on the flow of material between different activities/departments. The first step in this process is ascertaining the operation sequence for the manufactured parts as well as their production quantities. This data has been summarized for the selected parts being manufactured in Table 1.

Table 1. List of components and production quantities

No	Components	Operation Sequence	Quantity
1	Front Axle Assembly	E, A, E, I, C, G, E, A, C, D, K, I, C, G, F, H	2000
2	Differential Case	N, M, A, F, C, F	2000
3	Pin Pump Support	E, A, K, C, E, F	1000
4	Shaft Lower Link	E, A, F, K, J,	2000
5	Rail Shifters	E, C, F, I, F, C, G, F,	4000
6	Hydraulic Lift Cover	N, L, M, M, P	1000

Problems with the existing layout

Utilizing the production quantities and operation sequences of all six parts listed in Table 1 a From – To chart, (Figure 2), was developed showing the flow of material between different departments.

Based on the existing layout and the From – To chart, a number of problems were identified with the existing layout of the facility. They are listed as follows:

- No material flows to and from department B, however it does occupy a very central position in the layout.
- There is a large quantity of material flowing between departments A, E, and F, namely the lathe machine section and CNC machining section. The existing layout shows these departments at opposite ends of the existing layout.

	C	D	E	F	G	H	I	J	K	L	M	N	P
A	7		9	4					1		2		
B													
C		2	5	14	4		4		1				
D					2				2				
E			1				2						
F					2	8	8	2	2				
G						2							
H								2					
I									2				
J									2				
L											1	1	
M												2	1

Figure 2 From – To chart for different departments (quantities in 1000 units)

- There is also a large flow of material between departments F, H and I. From the existing layout it is visible that there are a few offices and the inspection station G that comes between these stations. Thus movement of parts between these stations is Rectilinear instead of Euclidean, which increases the work in process time.

THE REDESIGN PROCESS

Activity Relationship (REL) Chart

The activity relationship chart replaces the numbers shown in the From – To chart by a qualitative closeness rating. All pairs of activities are evaluated and a closeness rating is assigned based on the flow of material between the two activities. Closeness ratings are given in five categories A (10), E (15), I (22), O (23) and U (40), where the values in the brackets signify the percentage of each category in the total population. An A rating signifies the highest amount of material flow and U signifies the lowest amount.

Table 2. Closeness Ratings of different departments

	A	C	D	E	F	G	H	I	J	K	L	M	N	P
A	E	F		A	C									
E	F	E		C	A,I,H		F	F						
I		G, I			G	C,F,H	G	C,F,H						
O	D,M	D	A,C	K, I	J,K			O	F	E,F		A,C		
U	K	K					J	K	H,K	A,C,I,J	M,N	L,N,P	L,M	M

Activity Relationship Diagram

The activity relationship diagram in contrast to the REL chart depicts the spatial proximity of different departments on the basis of the REL chart. Thus, pairs of activities having the greatest material flow between them are placed adjacent to one another. Hence activities having an A rating shall be located next to one another and activities having a U rating would be placed far apart. The process of constructing an activity relationship diagram usually requires that compromises be made due to the lack of a binary ruling by which it can be ascertained if a relationship is satisfied or not. Figure 3 shows the activity relationship diagram for the case understudy.

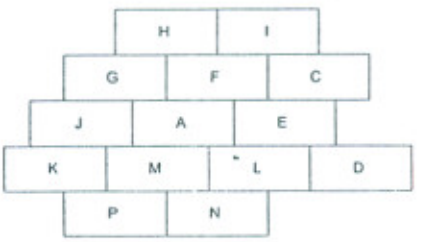


Figure 3 Activity Relationship Diagram based on REL chart

The activity relationship diagram is the basis for the development of the new layout. Thus the new facility layout was developed from the activity relationship diagram and is shown in Figure 4.

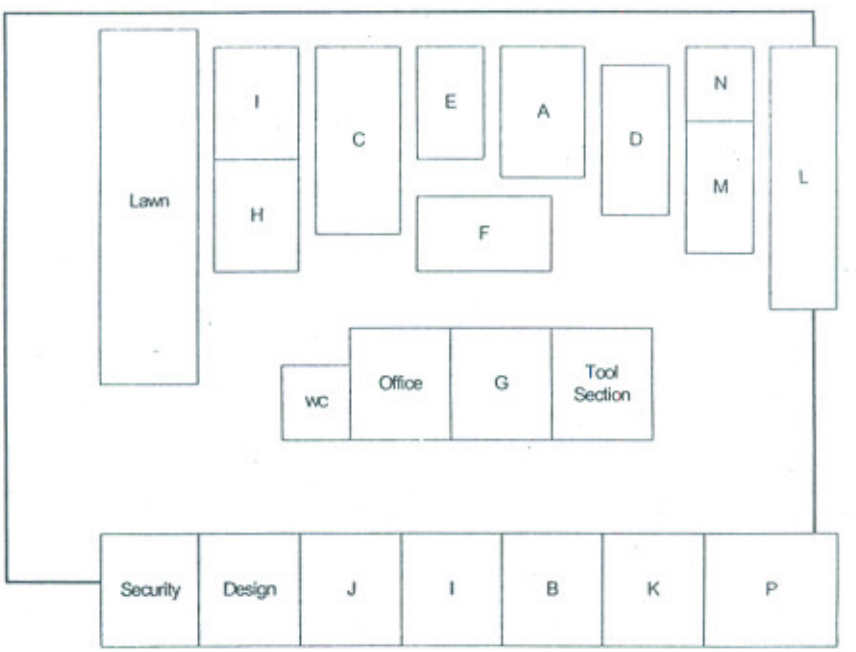


Figure 4. The redesigned layout based on the activity relationship diagram

RESULTS & DISCUSSION

In order to compare the two layouts, existing and proposed, a load-distance calculation method is employed. The load distance method can be used to compare alternative plans using information such as material flows, communication and personnel movement. Block plans are developed for both the existing and new layout as shown in Figure 5.

The two block plans are used for computing the load-distance measure between the departments, having the greatest closeness ratings (ratings of A, E and I), making use of rectilinear distance measure. The results of these computations are summarized in Table 3.

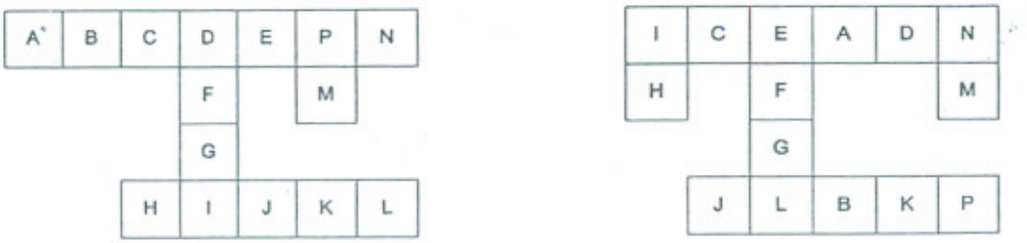


Figure 5. Block diagrams for the existing and redesigned layouts

The new layout gives a reduction of 27% in load-distance calculations in comparison to the existing layout. Furthermore, it also reduces the total amount of travel distance by 32%. As productivity and transportation costs are directly proportional to load-distance measure, the new layout clearly provides greater productivity along with reduced transportation costs.

Table 3. Load-Distance computations for the two layouts

Dept. Pair	Closeness Rtg.	Current Plan		New Plan	
	Load l	Distance d	Load-Dist. ld	Distance d	Load-Dist. ld
A, E	9	4	36	1	9
C, F	14	2	28	2	28
A, F	4	4	16	2	8
C, E	5	2	10	1	5
F, I	8	3	24	3	24
F, H	8	3	24	4	32
C, I	4	4	16	1	4
C, G	4	3	12	3	12
Total		**25**	**166**	**17**	**122**

CONCLUSIONS

The objective of this paper was to improve productivity and reduce work in process with the aide of facility redesigning. An existing manufacturing setup was taken as a case study and data about production sequences and quantities was gathered. Utilizing this data a new layout was developed, and with the aide of load-distance calculations it was shown to be more effective in comparison to the existing layout.

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DOING OUR BIT FOR SUSTAINABLE ENVIRONMENT

By

Engr. Mian Iftikhar Ahmad*

We can all do our bit for achieving sustainable environment by using the car less and by avoiding unnecessary journeys, by walking, by cycling, by using public transport, being more energy conscious, and by recycling waste which can help make the environment a cleaner place. Being fit and healthy, eating a balanced diet and taking adequate exercise, is also beneficial to the society and the economy. A healthy person economizes on expenditures and saves time for leisure or earning more money, and an unhealthy person is a burden on society and the environment.

Using Public Transport

Transport pollution is emitted at ground level from a mobile source, and is, therefore, a larger problem than other pollution sources. As an alternative to driving the car, walking, cycling or using public transport where it is suitable and safe to do so is a better option, particularly for short trips where using the car is not necessary and other alternatives exist. Where walking or cycling is impractical, people can consider taking public transport if it is available and convenient to use. A bus full of passengers is twice more fuel-efficient than using family cars. In addition, car sharing is an option to consider if you and your friends drive to work along the same routes.

Unfortunately, a dramatic shift to non-car based travel in Pakistan, at least, will only happen when the quality of public transport service improves. Currently, barriers to uptake include cost, travel time, and lack of availability of convenient (door to door) routes in comparison to car travel. These barriers will need addressing now or in the near future if public transport is to play a serious role in making Pakistan's transport system sustainable and public friendly.

Exercise, Cycling and Walking

Lack of physical activity or exercise, like a poor diet, can lead to a range of health and other social problems which if prevalent amongst large section of a society are not beneficial to a bright future.

Physical activity helps to control weight by consuming excess calories that otherwise would be stored as fat. In addition, regular physical activity can reduce risk for several diseases and health ailments including coronary disease and stroke, high blood pressure, obesity, back pain and osteoporosis. Research has shown that daily aerobic exercise such as brisk walking or cycling of as little as for 30 minutes, can halve the risk of coronary diseases and early heart attack.

Taking regular exercise need not be boring. Activities like swimming are means of increasing your activity and having fun with your friends at the same time. Such exercises will also help to unwind from work or studies and relieve stress and tension. Other ways to increase physical activity require only small changes in everyday routine, such as walking or cycling to school or work, or taking the stairs instead of the elevator.

Cycling is often the quickest mode to make short journeys. It also has the advantage that unlike motorized mode of transport, it does not cause air pollution.

The provision of cycle and pedestrian routes, segregated from the road network, may encourage an increase in the number of short journeys being made on bike or foot. This could

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be assisted by improving cycle parking facilities at convenient locations. Similarly, walking is a sustainable mode of transport available to all at no cost. The safer the walking environment the better, and hence the introduction of pedestrian lanes to city centers and improving pedestrian access to and within public transport facilities may increase the number of people that travel on foot.

Cycling and walking are also extremely healthy modes of transport, as they increase physical fitness. Cycling or walking briskly for half an hour a day can halve the risk of heart disease (that is as little as a 6 kilometer bike ride or 3 kilometer walk).

Energy Efficiency

The individual has little influence on how energy is produced; for example by coal, gas or hydro power or alternatively, by wind or solar power. However, the individual does have control on how that energy is used. Through the implementation of simple measures one can effectively bring about reduction in energy consumption. Using less energy also means savings on fuel bills. One can easily save about 10% of energy bills by shutting off use of energy when not needed.

The cumulative energy reductions by individuals would reduce the need for production, conserve stocks of raw materials such as coal, oil and gas, and bring about a reduction in pollutant gas emissions.

Recycling Wastes

Wastes production and distribution patterns will have to change to reduce emissions and resource use. The degree of improvement in resource use is, of course, a matter of debate, but there is a growing awareness that doing so can bring economic benefits as well as environmental improvements.

One can help to reduce the consumption of energy and raw materials used in manufacturing, by reducing the amount of waste produced, re-using products, and recycling them where possible. The common **3-R** principle, i.e., Reduce, Re-use and Recycle, should be followed where possible. Some examples of materials that can be recycled include paper, glass, plastics, clothing, aluminum cans, metals, and organic materials such as waste plants and food for composting.

Consumption of Resources

The ever increasing demand for products and services is taking a toll on the environment. Over exploitation of resources and manufacturing unnecessary by-products are increasing stresses on the natural world.

As a consumer, one often use too much, for example energy and/or water. Sometimes one produces too much waste products. Using too much natural and particularly non-renewable resources (like fossil fuels) today means fewer will be available to future generations. Every individual can reduce the amount it consumes.

Diet

Everyone is what it eats. There is much truth in this proverb. In today's society, unbalanced diet is increasingly leading to high levels of obesity and poor health. This can result as a consequence, in increased depression and stress, reduced performance at work, and enhanced health care costs. None of this is advantageous to a sustainable society.

Eating a balanced diet containing plenty of fruits and vegetables, not smoking, keeping physically active and keeping body weight within the healthy range of given height are factors which keep the body fit and away from coronary disease and certain cancers.

Education

Education is essential to establish an understanding of the importance of sustainable development and environment. Education can give people environmental and ethical awareness; it can develop the values and attitudes, the skills and behavior needed for sustainable development. The United Nations in its "Agenda 21" (adopted at its 1992 Conference on Environment and Development) emphasized the urgency of improving such awareness. The UN recommended the need to:

- make environment and development education available to people of all ages.
- introduce environment and development concepts, including those of population, into all programs, with assessment of major causes and issues. Decision makers attention needs to be drawn to this aspect for implementation.
- involve school children and communities in local and regional studies on environmental health, including safe drinking water, sanitation, food and the environmental and economic impacts of resource utilization.
- encourage all sectors of the society including industry, universities, governments and community organizations to cooperate in training people in environmental management.

Water Conservation

One often takes the ready availability of water for granted. Water is somewhat renewable resource, but its availability in a form readily usable for drinking and other domestic and industrial purposes is being placed under increasing stress as we use more and more. During periods of drought in particular, groundwater and reservoir supplies can become significantly diminished. The following points illustrate just how much water one consumes, and how one can attempt to reduce this level of consumption.

- One uses now around 100 liters of water each day on average, which is almost 100% more than consumption 30 years ago.
- Running the tap can use 10 to 14 liters of water a minute-which if saved will provide enough water for a light bath in only 5 minutes.
- Make sure to mend leaky taps, and turn off taps when not in use.
- Turn off the tap while brushing the teeth.
- Take showers, not baths and save enough water each week to make 1000 cups of tea.
- Once a week is all a lawn needs watering even in the hottest weather. Over watering can weaken the plants by encouraging the roots to come to the surface.
- Washing a small car may consume 40 to 50 liters –one can simply clean the car by a wet cloth saving all that water.

Please do not forget that it is obligatory on all humans as per injunction of Allah the Almighty in the Holy Quraan, "Eat and drink as much as is essential to support life but do not waste as Allah Almighty does not love those who waste".

In the end, let us repeat and remember our lesson that **we can all do our bit** for achieving sustainable environment by using the car less and by avoiding unnecessary journeys, by walking, by cycling, by using public transport, being more energy conscious, and by recycling waste which can help make the environment a cleaner place. Being fit and healthy, eating a balanced diet and taking adequate exercise, is also beneficial to the society and the economy. A healthy person economizes on expenditures and saves time for leisure or earning more money, and an unhealthy person is a burden on society and the environment.

SOLIDIFICATION SEQUENCE IN ALUMINIUM BRONZE CONTAINING IRON

BY

Dr. Javed Iqbal and Dr. Faiz-ul-Hasan*

ABSTRACT

The aim of present investigation was to study the sequence in which the various phases/ precipitates appeared during continuous cooling from temperature approaching the solidus, in an as- cast aluminium bronze containing irons. This alloy is used for making components for use in corrosive environments. It was found that at high temperature the microstructure consisted of only β-phase. Upon quenching, the β-phase transformed into martensite, which had 3R crystal structure. On further cooling the iron-rich precipitates, having Fe_3Al structure, nucleated in the β -phase. As the temperature was further lowered the α-phase formed on the β -grain boundaries as well as on the iron-rich precipitates .It was also found that the presence of iron-rich particles impeded the growth of α -phase and was the main cause of refinement of microstructure observed in this alloy.

INTRODUCTION

Copper-base alloys are well known for their strength and corrosion resistance and are therefore extensively used for marine applications. Two most commonly used aluminium-bronzes are BS 1400 AB1 and BS1400 AB2. The crystallography, chemistry and microstructure of AB2 have been thoroughly investigated (1-3), but the AB1 alloy has not been studied in any great detail. The results of the microstructural study of AB1 alloy, which has been described elsewhere (4, 5), show that it consists of α, β and intermetallic precipitates.

Brezina(6) has reported that the presence of iron in the binary Cu-Al alloy results in the formation of iron-rich precipitates in addition to phases present in binary system. Yutaka (7) suggested that the iron-rich precipitates are Delta-iron and are uniformly distributed in both α and β. According to Upton (8) the microstructure of slowly cooled copper-aluminium-iron alloy consists of $\alpha + \gamma_2$ and iron-rich precipitates. Maken and Smith (9) reported that the precipitation of iron-rich particles occurred at the beginning of solidification. The formation of this form of precipitates during early stages of solidification was believed to refine the as-cast grain-size.

EXPERIMENTAL

The composition of the alloy used in the present investigation is given in Table 1.

Specification	Cu	Al	Fe	Mn	Si
BS1400AB1	87.94	8.63	3.23	0.18	0.02

Table 1. Composition of alloy in Wt %

Continuous Cooling Transformation Experiment

For this experiment the samples were heated in a vertical tube furnace. The specimens were suspended in the furnace along with a thermocouple. All the specimens were solution treated for 30 minutes at 1000°C before the temperature was allowed to decrease at a rate of approximately 5°C/minutes. A cooling curve was recorded, (Figure 1). The specimens were successively released so as to quench into a water tank below the tube furnace at the required temperature levels as the temperature decreased.

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Microscopy

For metallographic study the samples were prepared for optical by using conventional techniques. The polished samples were etched in 10% ferric nitrate solution in water. Microscopy was carried out on Zeiss photomicroscope.

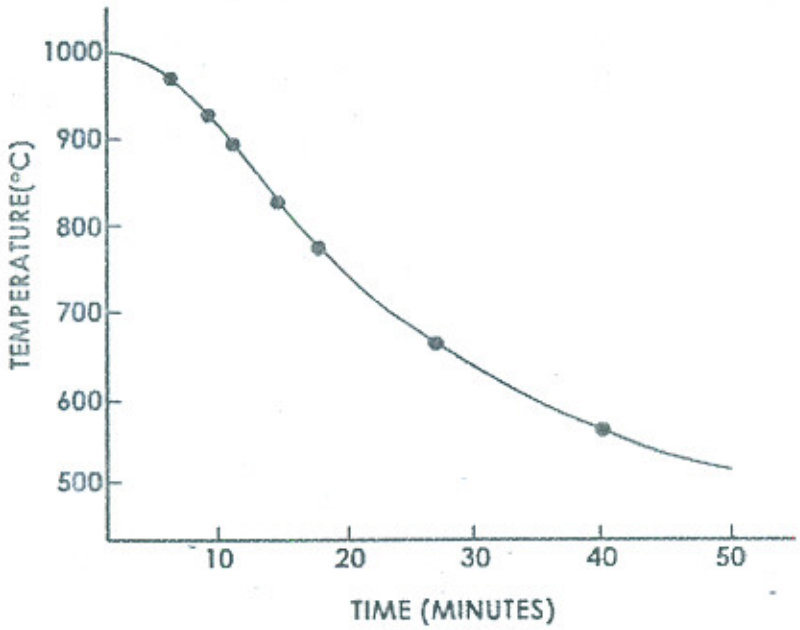


Figure 1. Cooling curves recorded during the continuous cooling transformation experiment (cooling rate = 5°C/ min)

RESULTS

The microstructure of the sample quenched from 1000°C. (Figure 2), illustrates that at this temperature the alloy consisted of only the β-phase; the high temperature β -phase has transformed to martensite upon quenching.

Sample quenched from 950°C, did not show any further microstructural change. However, as the temperature dropped to 900°C, the iron-rich particles (Fe_3Al) were nucleated inside the β -grains and as well as at the grain boundaries, (Figure 3).

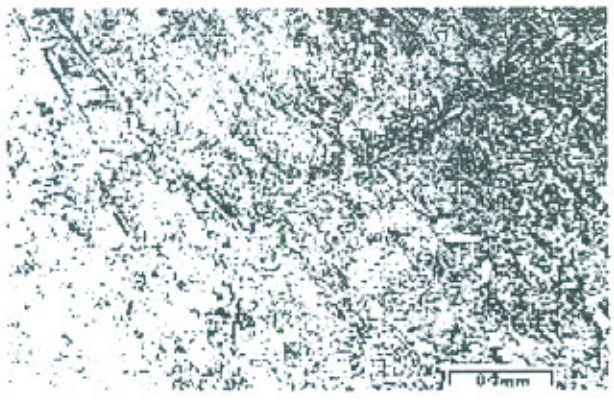


Figure 2. Micrograph taken from a sample which was quenched from 1000°C .

At about 860°C, the α-phase started to precipitate, Figure 4; the nucleation of the α-phase took place either at the β-grain boundaries or at the iron-rich particles inside the β - grains. Further growth of α and the iron-rich particles continued with decreasing temperature. There was clear evidence that as the α-grains grew during cooling, their growth was impeded by iron-rich particles, which were located in the β, Figure 5.

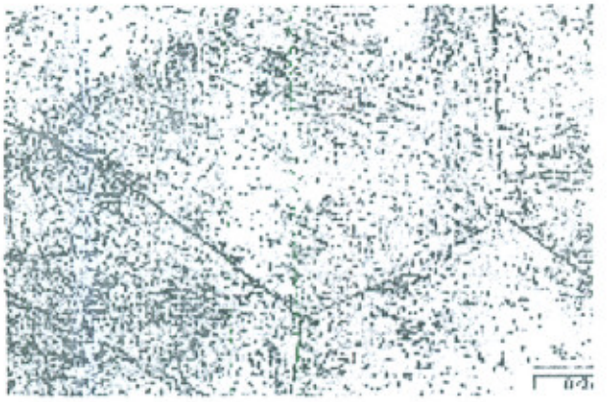


Figure 3. Micrograph taken from a sample, which was quenched from 950°C.

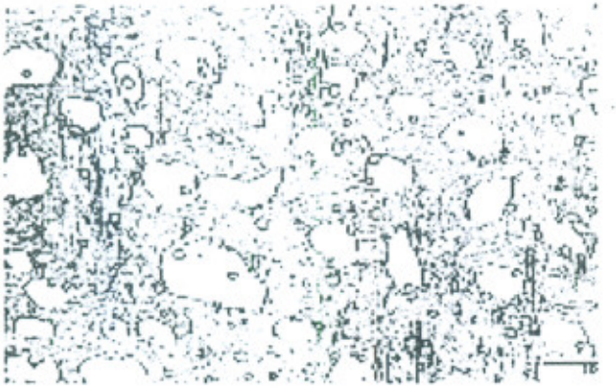


Figure 4. Micrograph taken from a sample which was quenched from 850°C.

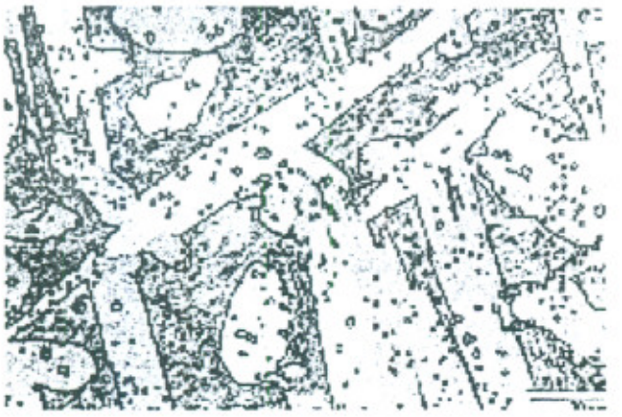


Figure 5. Micrograph taken from a sample, which was quenched from 750°C.

The microstructure of the sample quenched from 550°C, Figure 6, was similar to that of the as-cast sample. Figure 7, which indicated that the alloy did not undergo any appreciable further change below this temperature. A schematic representation of the development of the microstructure is shown in Figure 8.

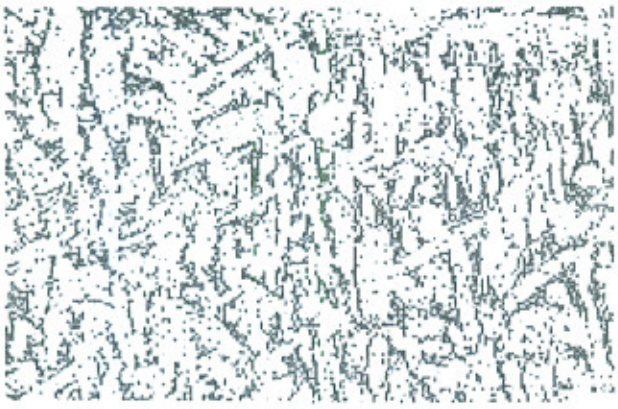


Figure 6. Micrograph taken from a sample which was quenched from 550°C.

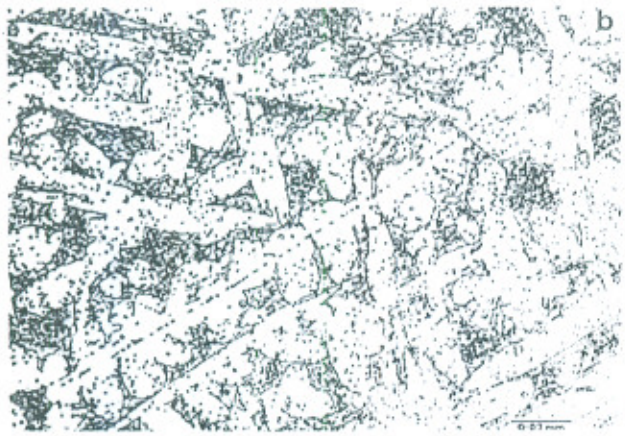


Figure:7 Micrograph taken from as-cast sample showing distribution of phases.

DISCUSSION

Additions of iron to aluminium bronzes are reported (4,5) to lead to much finer grain sizes compared with that of the equivalent binary alloys. This may be due to the formation of iron-rich particles during early stages of solidification. It is believed that these particles inhibit the growth of the α -grains with a consequent reduction in the scale at which the α and β phases are distributed in the as-cast microstructure (9). Although, the present results support the view that the presence of iron causes the microstructural refinement of the as-cast alloy, the mechanism by which this occurs is essentially two-fold. The present work shows that the alloy completes it solidification as a fully β structure, and that the β-grains can undergo substantial growth before the iron-rich particles are precipitated. The iron-rich precipitates are formed prior to the nucleation of α, and since the α-phase nucleates both at the β-grain boundaries and at the iron-rich particles inside the β-grains, the number of nucleation sites for α is higher and the consequent mean grain size is small. Also the growth of α during further cooling appears to be hampered by the iron-rich particles, (Figure 5), and this imposes an additional restriction on the eventual size of α-phase precipitates.

Figure 7, illustrates the fineness of the as-cast microstructure, and also the position of the prior β grain boundaries. The size of the parent β-grains is about 0.5-1.0 mm, which is very large in relationship to the fineness of α / β phase distribution. This clearly shows that the microstructural refinement brought about by iron additions is not the result of a small β-grain

size in the as-cast alloy. In Figure 7, a row of closely spaced Fe_3Al particles, which runs diagonally across the micrograph can be seen. These precipitates had precipitated at a pre-existing β-grain boundary supporting the view that the alloy had

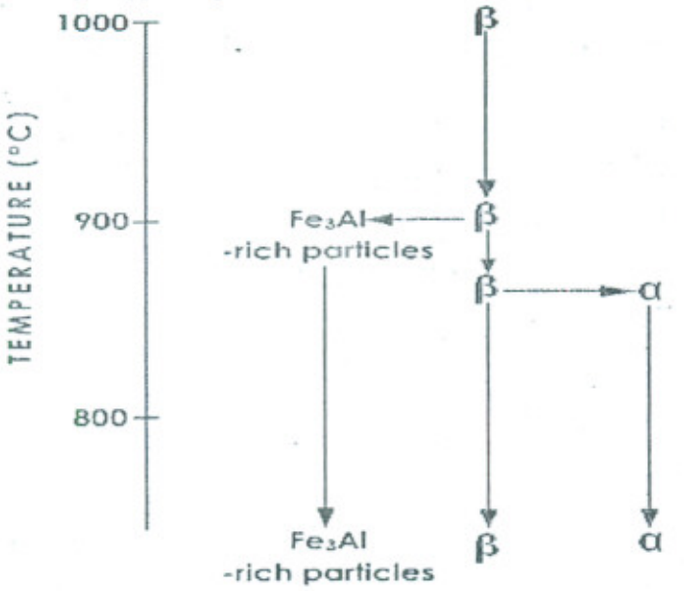


Figure 8. Schematic illustration of the development of as-cast alloy.

solidified as a whole β structure, and that the iron-rich particles had precipitated from the β-phase (9).

It was noted that in nickel-aluminium-bronze (AB2), the microstructural refinement produced by iron was not as significant as in AB1 alloy. This may be attributed to the fact that in AB2 alloy, the precipitation of Fe_3Al particles occurs after the nucleation of α-phase, which means that the principal nucleation sites available to α are only the β-grain boundaries. However, during further cooling the growth of the α-grains can be inhibited by the Fe_3Al particles, which may cause some refinement of the as-cast microstructure. The precipitation of Fe_3Al particles after the nucleation of α, in AB2 also suggests that at higher temperatures the solubility of iron in the β-phase is enhanced due to the presence of nickel.

The present results also show that the "retained β-phase" was essentially martensite. The equilibrium diagram of Cu-Al-Fe shows that β cannot exist in equilibrium at temperatures below approximately 550°C, as it is subjected to eutectoid reaction which involves its breakdown to $\alpha + \gamma_2$. Because of the relationship between cooling rate and equilibrium conditions, except when very slow cooling rates are involved, there is always a likelihood of β to transform into martensite. During the present work no γ_2-phase was observed in the as-cast microstructure. This is probably due to the fact that cooling rates investigated were relatively rapid.

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IMPACT ASSESSMENT OF MIRPURKHAS TILE DRAINAGE PROJECT IN THE SINDH PROVINCE OF PAKISTAN

By

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ABSTRACT: Twin menace of waterlogging and salinity is one of the major causes for low agricultural production in the country. Government of Pakistan has invested considerable money to mitigate the waterlogging and salinity problem and to improve the land and groundwater conditions through installation of a number of tile drainage projects. It is imperative to evaluate the impact of those projects to determine if the intended benefits have been achieved. In this paper, the Mirpurkhas Tile Drainage Project (MKDP) in the Sindh province, has been assessed in terms of its impact on improvement of land and groundwater conditions. For this purpose, various performance indicators were evaluated. The analyses revealed that tile drainage system was capable of controlling watertable in that area. After the installation of drainage system, the disaster area with watertable depth 0-150 cm reduced from 90% to 11% with a net decrease of 79% during 1994 to 2000. During pre-project (1993) base-year, 36% of the farm area was left fallow due to waterlogged and salinity conditions, which reduced to 24% in the post-project year (2003). After implementation of the project, the cropped area increased by 30% as compared to the base year. This data revealed that reclamation of affected lands has been slow. As investigated, the main reason for this slow benefit was the limited financial resources available with farmers to reclaim/restore the fertility of waste lands. Another reason was the poor operation and maintenance (O & M) of the drainage sumps. As a result cropping intensity increased from 129% to 152% with a net increase of 23%. Also crop yields improved significantly. The yield for most crops increased from 41% to 147%, except rice for which the yield decreased by 23% mainly due to limited sub-irrigation as a result of tile drainage operation. Therefore, it is justified to say that the objectives have been achieved by this project in terms of lowering of watertable and increase in cropping intensity as well as crop yield. However, the benefits of project can further be increased by improving O & M facilities, capacity building of staff, credit facilities to the farmers as well as provision of agricultural extension services.

1. INTRODUCTION

Irrigated agriculture being dominant sector of Pakistan's economy contributes about 24% to the country's GDP, employees 48.4% of total workforce and facilitates 70% of export revenues. Almost 68% population of Pakistan is directly or indirectly supported through this sector for their livelihood (Govt. of Pakistan, 2003). After the advent of canal irrigation without adequate drainage facilities, agricultural lands of Pakistan have suffered from the problem of waterlogging and salinity. In early sixties when this situation caused a threat to crop production and natural environment of the country, the Government of Pakistan put a great emphasis to remedy the situation. As such, a considerable part of past investments (~ Rs.37 billions) in water-sector has gone to combat the problem of waterlogging and salinity. Allocation in the 8th plan for water sector was 13% of the total budget and out of this about 70% was earmarked for drainage and reclamation of affected lands.

In order to alleviate the problem of waterlogging and salinity in Pakistan, several methods such as mechanical and biological reclamation have been applied by WAPDA, under the Salinity Control and Reclamation Projects (SCARPs) which were launched to mitigate this twin menace. Engineering measures to control this problem mainly comprised surface drainage, subsurface drainage, interceptor drains, tubewells, canal lining, etc. Till the year 2003, the Govt. of Pakistan has made tremendous efforts to mitigate the impact of waterlogging and salinity. Since 1960's sixty-one SCARPs have been completed and a few more projects are still going on. So-far the construction of 11,525 km of surface drains, 13,000 km of subsurface tile drains and over 16,000 tubewells, covering an area of 8.50 MH have been accomplished (*Bhutta, 2003, personal communication)*.

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Bhutta et al. (2001) evaluated various techniques (such as, canal lining, interceptor drains subsurface tile drainage, etc.) adopted in Pakistan to mitigate the impact of waterlogging and salinity problems. They expressed that subsurface tile *(pipe)* drainage had been relatively more successful to control waterlogging and salinity problems as compared to other methods. The tile drainage technology was introduced in Pakistan about three decades ago to control waterlogging and salinity. To-date, eight subsurface drainage projects have been installed in various provinces of the country (Azhar et al., 2003). Although, the performance of these projects has been reported to be below expectations mainly because of deficiencies in policy and institutional matters and inadequate O&M of completed drainage projects (WAPDA, 2002), no systematic effort has been made to analyse those projects in terms of *"improvement evaluation"*. Keeping in view the huge investments incurred and the benefits attached with those projects, it is of great significance to evaluate the performance of those systems and to suggest improvements for future drainage systems. Hence, a study was conducted by IWASRI under National Drainage Programme (NDP). Under this study, Mirpurkhas Tile Drainage Project (MKDP), Sindh was evaluated with respect to the improvement of land and groundwater conditions in the area.

2. DESCRIPTION OF STUDY AREA

The Mirpurkhas Tile Drainage Project (MKDP) is located in the Sindh province of Pakistan. In this project, approximately 24,281 hectare (ha) area was identified that was unsuitable for tubewell drainage, due to extremely poor aquifer conditions. Hence, for this area drainage was recommended to be carried out using tile (pipe) drainage system including 65 sump/pump stations. In MKDP, the area drained by a single sump/pump station varied from 162 to 485 ha with an average of 364 ha. For feasibility study, within MKDP a pilot study area of 810 ha was selected. Tile drainage in this area was implemented by WAPDA during 1994-97 to control waterlogging and salinity in the area. The designed watertable depth for this system was 122cm (Sir MacDonald et al., 1996).

3. DATA COLLECTION AND ANALYSIS

In order to assess the success of MKDP, the impact of drainage facility with respect to various *performance indicators* (*impact indicators*) was investigated. The various impact indicators investigated in this study were: (i) watertable control, (ii) land reclamation, (iii) cropped area, (iv) cropping intensity, and (v) crop yields. For this analysis, relevant data were collected from various sources such as WAPDA, Provincial Irrigation and Power Department, Agricultural Department, and through farmers' interviews. The required data were collected for three stages i.e. *before*, *during*, and *after* the implementation of drainage system. The collected data were first screened for their integrity, and then analysed in various ways to assess the success of drainage project based on above stated performance indicators. In this study, for quantitative comparison between pre and post-project conditions, the numerical value of respective impact indicator (*impact parameter*) has been used. Hence, the *impact parameter* used was the design (i.e. targeted) value of respective impact indicator, if specified/documented (e.g. designed watertable depth, targeted yield etc.). In case, the design value of respective impact indicator was not documented, the pre-project value of respective impact indicator was used as the *base value* for quantitative comparison. The analysis is given in the following section.

4. RESULTS AND DISCUSSIONS

In this section, the analysis of five performance indicators namely; watertable control, land reclamation, cropped area, cropping intensity, and crop yields have been evaluated and discussed.

4.1 Watertable (WT) Control

As stated earlier, the drainage system in MKDP was installed during 1994-97. The designed watertable depth was 122 cm below ground surface (Sir MacDonald et al., 1996). However, much information was not available for this area. However, the measured groundwater

table data of this project area for the period 1994 to 2000 was available with WAPDA (1997 and 2001). The percentage of gross area at MKDP under different ranges of depth to watertable during the years 1994 to 2000 is shown in Figure 1. The need for drainage is clearly demonstrated from the depth to watertable values. As can be observed from Figure 1, just before the installation of drainage system in 1994, the area with watertable depth 0-150 cm was 90%. After the installation of drainage system in 1997, the percentage of 0-150 cm depth area gradually reduced and ultimately became 11% in the year 2000. Thus, a significant (79%) reduction in the high watertable area has been observed in a period from 1994 to 2000. This clearly indicates the positive effect of subsurface drainage system to reduce the waterlogging in a certain area.

The year-wise subsurface drainage area with designed watertable depth (122 cm) during construction (1994-97) period is given in Table-1 and graphically presented in Figure 2. As can be observed, the overall area with designed watertable depth progressively increased during this period. This depicts the positive effect of drainage system installation to control watertable depth at MKDP area. At the same time, Figure 1 shows that during 1997, 65% of the area was having watertable depth >150cm which further increased to 89% during the 2000 year. This lowering of watertable to a depth more than 150 cm (designed watertable depth of 122cm) indicates the over-designed situation of the subsurface drainage system.

4.2 Land Reclamation

In general, the wasted (out of production) land resulting from the twin menace of waterlogging and salinity is expected to reduce as the drainage system is implemented in the area. In this study, this reduction in waste land is termed as *land reclamation*. Farmers' interviews revealed that during the pre-project (1993) base year, 36% of farm area was out of production (wasted) due to waterlogging and salinity problems, which have now reduced to 24% during the 2003 post–project year. As informed by the farmers, that 24% waste land was existing mainly due to salinity problem. This data revealed that reclamation of affected lands has been slow. As investigated, the main reasons for this slow benefit were the limited financial resources available with farmers to reclaim/restore the fertility of waste lands, and shortage of irrigation supplies during the post-construction period to leach down the excess salts. Another reason was the poor operation and maintenance (O&M) of the drainage sumps at this site. This

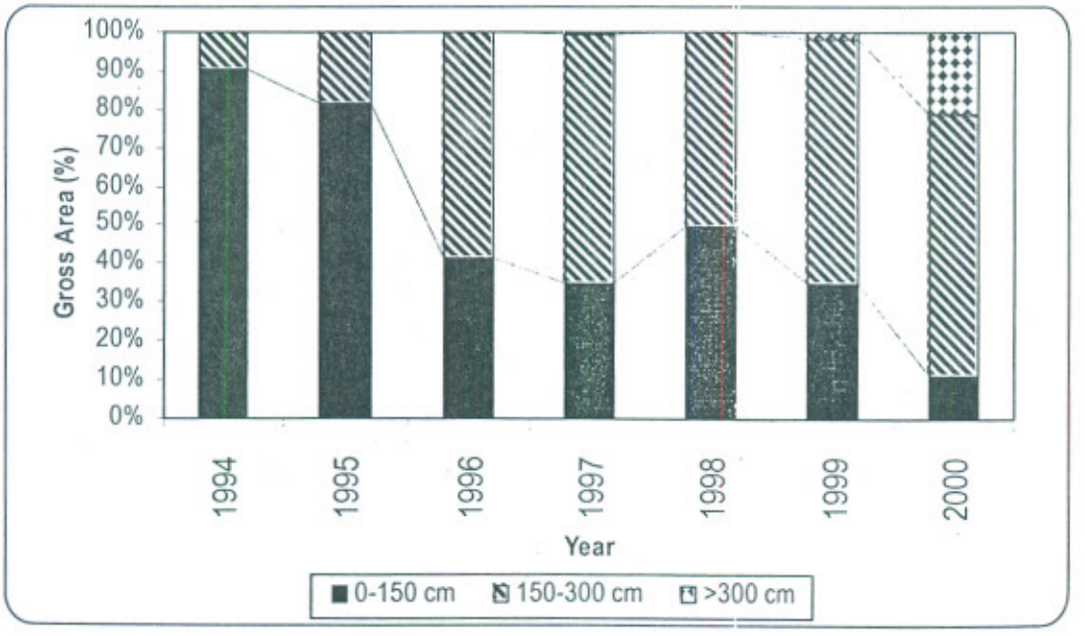


Figure 1 Percentage of Area Under Various Watertable Depths

Table-1 Subsurface Drainage Area With Designed Watertable Depth of 122cm

(% gross area)

Year	Pre-monsoon	Post-monsoon
1994	35.8	18.8
1995	31.0	30.1
1996	34.8	48.6
1997	44.4	51.4

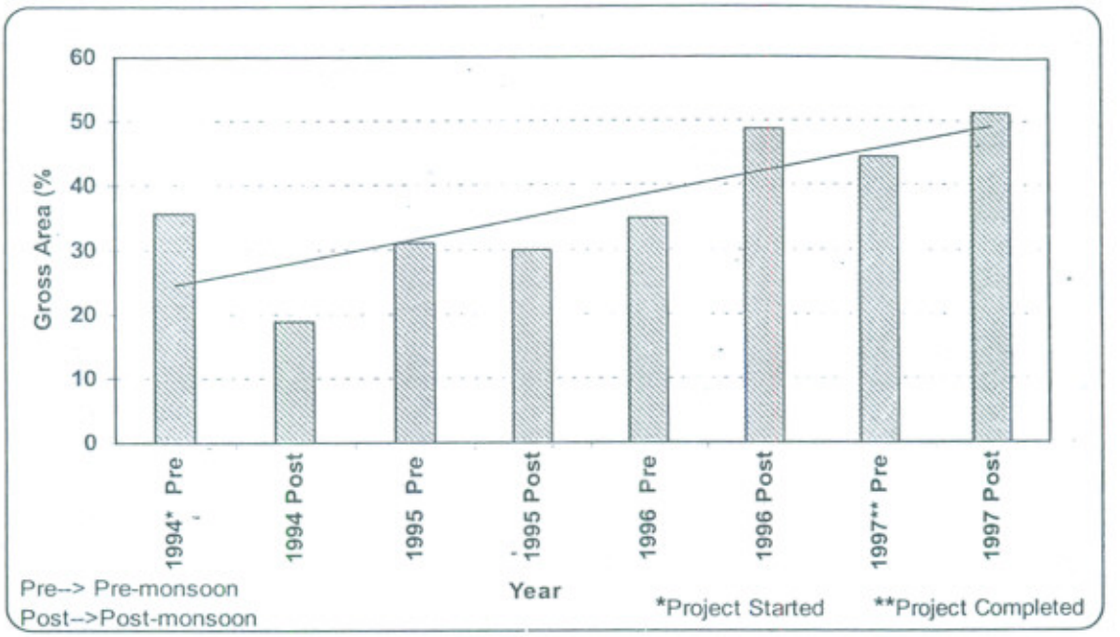


Figure 2 Percentage of Area Within Designed Watertable Depth (122cm)

analysis showed that efforts made to alleviate the problems of waterlogging and salinity through implementation of tile drainage system had not been up to the expectations mainly due to other associated problems. However, the quantitative comparison did indicate the positive impact of tile drainage system in terms of land reclamation in the area.

4.3 Cropped Area

In general, the cropped area under various agricultural crops is expected to increase with the implementation of subsurface drainage system. At MKDP area, the dominant crops were found to be sugarcane, cotton, rice, wheat and fodders. The percent *"cropped area"* data collected through farmer's interviews for this study is given in Table-2. With regards to the *cropped area parameter*, it is worth mentioning that for quantitative comparison no specific design value of this impact indicator was documented for this project. Hence, for this impact indicator the quantitative comparison was made based on the change in pre and post-project conditions of this project.

Table-2 Cropped Area Under Various Crops at MKDP (%)

Crop	Pre-Project (1993-94)	Post-Project (2002-03)	*Change (%)
Cotton	56.0	63.8	14
Rice	18.3	5.0	-73
Sugarcane	42.3	54.3	28
Wheat	52.0	69.5	34
Oilseed	23.0	31.0	35
Kharif Fodder	16.5	30.3	84
Rabi Fodder	8.5	14.0	65
Overall			27

* % difference in pre and post-project years

The pre and post-project change in cropped area under major crops is graphically presented in Figure 3. It can be observed that implementation of the project resulted in the increase of cropped area under almost all crops such as cotton (14%), sugarcane (28%), wheat (34%), oil seed (35%), Kharif fodder (84%) and Rabi fodder (65%). However, the area under rice decreased by 73%, due to the shortage of irrigation supplies during the post-project year. The overall cropped area has increased to the tune of approximately 27% in the post-project (2002-03) year as compared with the pre-project (1993-94) base year. Based on the above quantitative analysis of *cropped area*, it was revealed that there was not significant increase in the cropped area. As reported by the farmers, the main reason for this low benefit at MKDP was poor operation of the drainage sumps. However, in broader terms it can be said that there was a positive impact of subsurface drainage system in terms of increase in cropped area.

4.4 Cropping Pattern

Cropping pattern for a particular area depends on numerous factors such as quality and quantity of available irrigation water, condition of soil, climate, size of holdings, marketing facilities, market prices, availability of labour, dietary need of the people, forage requirements and state policies etc. Figure 3 shows the comparison of change in cropped area under various crops at MKDP. This figure indicates that cropping pattern of the area has been changed due to the project. At MKDP, due to drainage facilities the watertable has gone down and resulted in change of cropping pattern. As a result, area under various crops increased, whereas area under rice decreased. Probable factor could be sub-irrigation due to high watertable under pre-project conditions which diminished as a result of the drainage facilities.

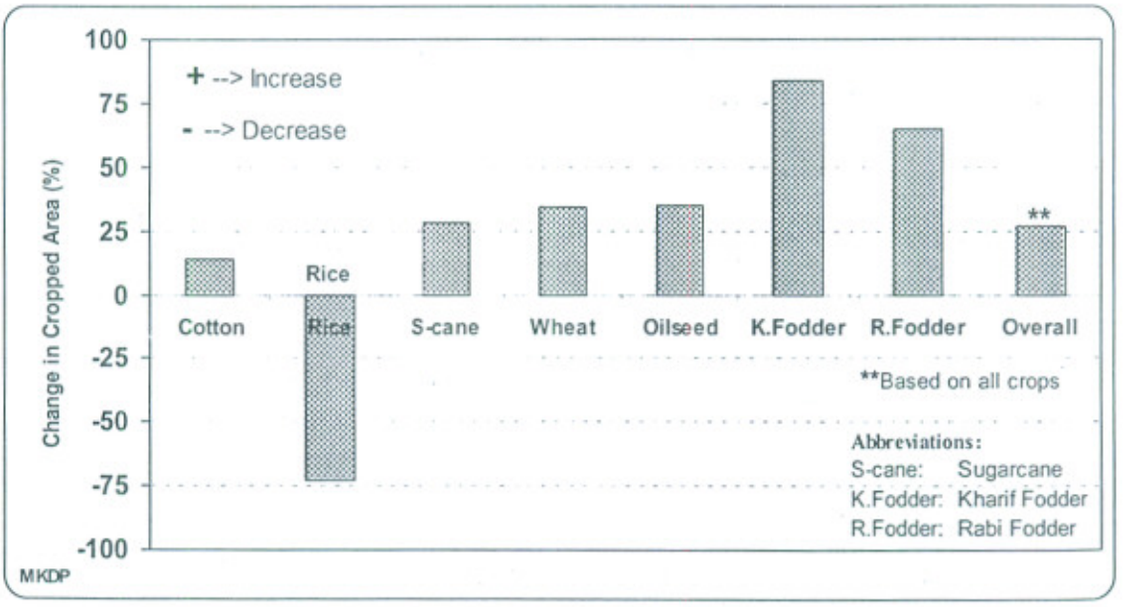


Figure 3 Change in Cropped Area at MKDP

4.5 Cropping Intensity

In general, the cropping intensity is expected to increase with the implementation of subsurface drainage system. Analysis of the relevant data indicates a 23% increase in the cropping intensity. The data is based on farmers' interviews at MKDP. The pre and post-project cropping intensities at MKDP are graphically shown in Figure 4. It was observed that during the pre-project (1992-93) year, annual cropping intensity was 129% (Kharif 64%, Rabi 65%). The cropping intensity was increased to 152% (Kharif 76%, Rabi 76%) during the post project (2002-03) year. As can be observed, there was an increase of only 23% (from 129% to 152%) in total cropping intensity over a period of about ten-years (i.e. 1992-93 to 2002-03). The above analysis revealed that there was an improvement (of 23%) in terms of cropping intensity in MKDP area due to drainage system installation.

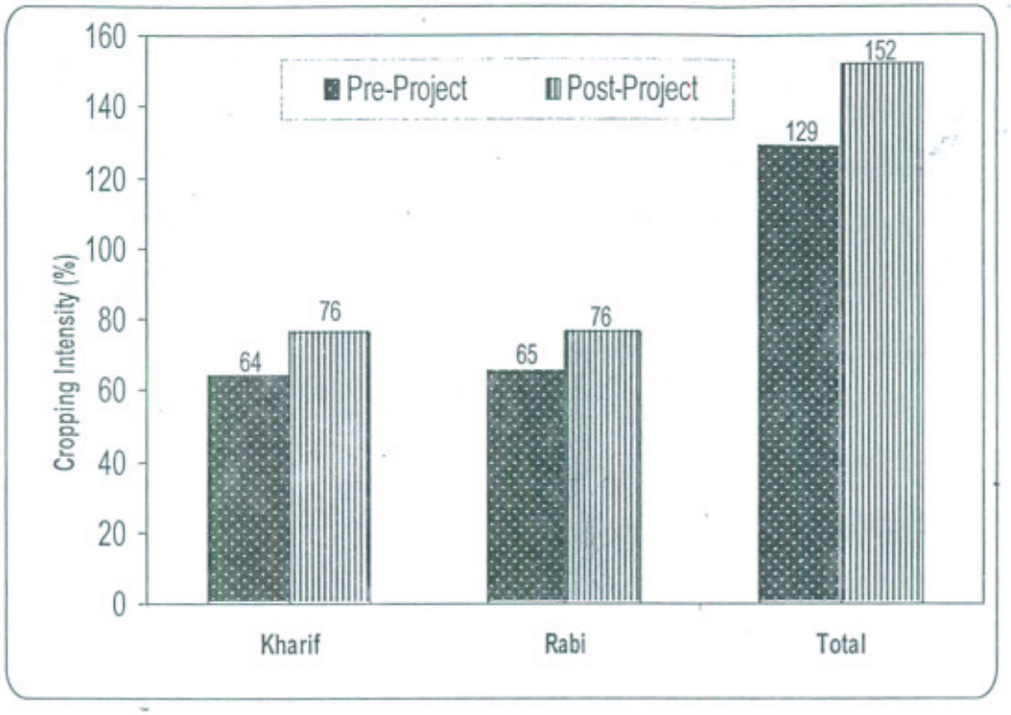


Figure 4 Pre and Post-Project Cropping Intensities at MKDP

4.6 Crop Yields

Crop yield is function of many variables such as farm management, system of land tenure, soil potential, quality of irrigation water, provision and supply of farm inputs, credit facilities and extension efforts in disseminating modern technology etc. From the performance point of view of drainage system operation, crop yields are generally expected to increase. The pre-project (1992-93) and post-project (2002-03) yields of major crops at MKDP as collected through farmer's interviews are given in Table-3. As can be observed, during the post-project period with the exception of rice crop, significant increase in the yields of almost all crops was achieved as compared with the base year's conditions. The pre and post-project change in yields of various crops is graphically shown in Figure 5. As can be observed from this figure, there was a significant increase in the yields of cotton (77%), sugarcane (78%), chilli (147%), wheat (66%) oilseed (45%), onion (133%) and pulses (41%) crops, whereas in case of rice crop the yield was decreased by 23%. This analysis revealed that yields of various crops increased showing the positive impact of drainage system installation.

Table-3 Yields of Major Crops in MKDP Area (kg/ac)

Crops	Pre-Project (1993-94)	Post-Project (2002-03)	Change* (%)
Cotton	480	850	77
Rice	1300	1000	-23
Sugarcane	21500	38375	78
Chilli	635	1567	147
Wheat	663	1100	66
Oilseed	213	308	45
Onion	3000	7000	133
Pulses	320	450	41

* + Increase ; - Decrease

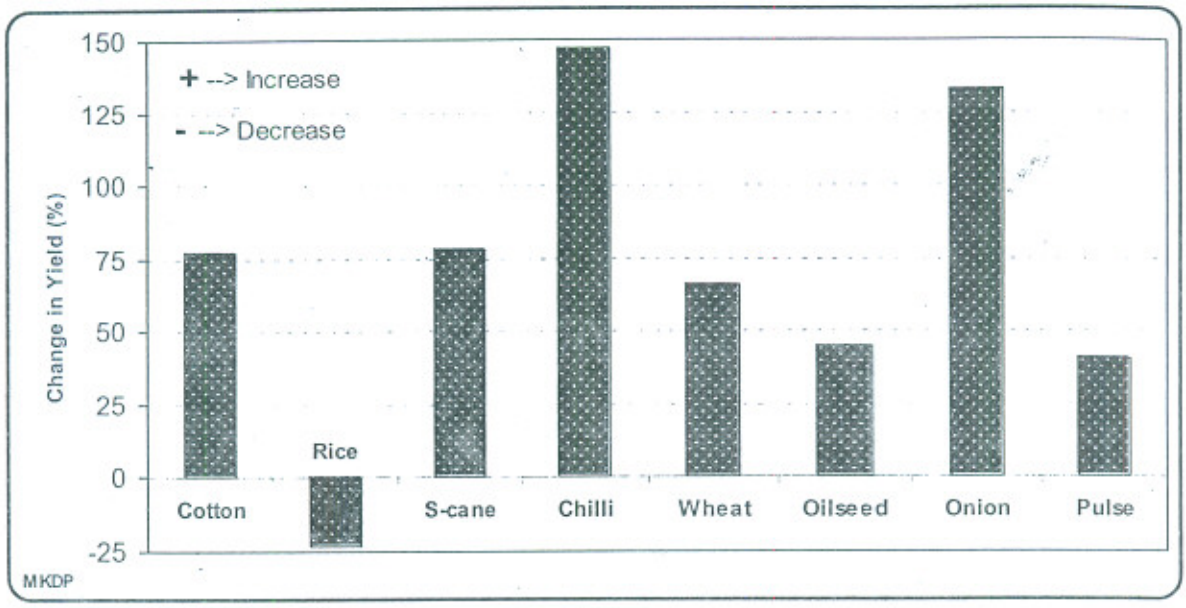


Figure 5 Pre and Post-Project Change in Yields of Major Crops at MKDP

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the analysis of performance indicators of tile drainage system at MKDP, following conclusions could be drawn:

- The field measurements carried out during the study and its analysis revealed that the tile drainage system was capable of controlling watertable. This was indicated with the fact that disaster area with watertable depth 0-150 cm reduced from 90% to 11% with a net decrease of 79% during 1994 to 2000, which proves the effectiveness of tile drainage system in this area.

- After the project installation, during post-project period (2000 year) the lowering of watertable to a depth more than 150 cm (designed watertable depth of 122 cm) revealed that the system was over-designed.

- The analysis of data shows that drainage system installation resulted in the increase of cropped area under almost all crops such as cotton (14%), sugarcane (28%), wheat (34%), oil seed (35%), Kharif fodder (84%) and Rabi fodder (65%). However, the area under rice reduced by 73%. The overall cropped area increased by about 27% as compared with the pre-project base year.

- Cropping intensity data collected revealed that project implementation resulted in an increase of annual cropping intensity from 129% during pre-project to 152% during post-project (2003-04) year, with a net increase of 23%.

- There was significant increase in the yields of cotton (77%), sugarcane (78%), chilli (147%), wheat (66%) oilseed (45%), onion (133%) and pulse (41%), whereas in case of rice crop the yield was decreased by 23%. Hence, in most of the cases except rice the crop yields increased with a range from 41% to 147%. Thus the overall yield trend of various crops depicted positive impact of drainage system installation in the study area.

- The objectives of drainage system installation have been achieved by this project in terms of lowering of watertable and increase in cropping intensity as well crop yields.

The benefit can further be enhanced by improving the operation and maintenance of the system.

5.2 Recommendations

i). Operation and maintenance (O&M) of drainage system demands careful and concrete measures. Therefore, the concerned agencies responsible for O&M of the system should have proper trained staff to run the sophisticated sump/pump systems.

ii). The operating agencies face the chronic problem of paucity of funds for O&M of the newly handed-over large scale projects. Hence, sufficient funds should be made available for post-construction running of the drainage systems to achieve the full/expected benefits from these systems.

iii). The agriculture extension services should be strengthened in drainage areas to educate the farmers regarding their feedback to the installation and operation of drainage systems.

iv). In order to get the maximum benefits from the installed drainage systems, farmers should be facilitated with easy credit facilities.

v). After the installation of drainage system, the irrigation requirements of crops are significantly changed due to reduced sub-irrigation. Therefore, to avoid the yield losses, the post-construction irrigation supplies should be carefully reviewed and improved accordingly.

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INTEGRATED MANAGEMENT SYSTEMS FOR BUSINESS SUCCESS
HOW TO INTEGRATE ISO 9000 AND ISO 14000 SYSTEMS

By

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By the mid of 2002, over 365,000 businesses world wide had been registered to the ISO 9000 quality management system (QMS) standards. While the number of companies using QMS (ISO 9000) continues to grow, use of the ISO 14000 environmental management system (EMS) standards could have an even greater impact on businesses globally. The ISO 14000 series of standards was developed by ISO Technical Committee (TC) 207 for guidance in environmental management systems and tools. As of January 2002, almost 44,000 organizations worldwide had already become registered to ISO 14001.The momentum building with ISO 14001 makes it clear that environmental management is becoming the new business priority.

Similarities Between ISO 9001 and ISO 14001

Companies that have already implemented quality systems which are comprehensive enough to meet the ISO 9001 standards have a clear advantage in implementing an EMS. There are many similarities between these ISO 9000 standards and ISO 14000. All management systems, whether focused on quality, safety, or the environment, have certain basic elements. These include : Policy defined-organization and responsibilities defined and documented standard practices, control of critical operations, document control (ensuring up-to-date documents are available where needed), training records system, internal audits, corrective action system, and management review for continual improvement. In the case of ISO 9001 and ISO 14001, there are similar (although not identical) requirements for all of these core elements.

Differences Between ISO 9001 and ISO 14001

Although quality and environmental systems are based on the same management system framework, there are some critical differences. In addition to the core elements identified above, all management systems also have some elements, which are unique to their particular focus area. For example, a quality system will include evaluation of suppliers and review of customer contracts. An environmental system will include methods of evaluating environmental impacts and systems for responding to emergencies. In addition to these specific unique clauses, there is a key underlying difference between a quality based system and an environmental system. In a quality system, the major system requirements are defined by customers. Although other stakeholder needs may be considered, customers are the only ones directly affected by the quality of the products and services. This means that the goals of a quality system are generally quite clear -- to meet or exceed customer requirements. Differing requirements from various customers are the only complexities which may complicate the system. The situation for environmental systems is not so straightforward. Customers may still be interested in a company's environmental impacts, but there are many additional stakeholders to consider as well. Regulatory bodies, local communities, and environmental activist groups all have an interest in a business' environmental performance -- and all have a potential impact on the business if they're displeased with the performance. Additional system requirements may also come from international treaties, industry-specific programs, and codes of practice. This all adds up to a very complex and constantly changing set of requirements from a wide variety of stakeholders. Among all of these external requirements, don't forget the underlying internal requirements for quality and environmental systems -- to have a successful business! Somehow, businesses have to meet these varied external needs, possibly including both ISO 9001 and ISO 14001 registration, and still maintain a competitive and profitable business.

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Integrating Systems for Business Success

The answer is to develop and maintain a comprehensive business management system, which addresses quality and environmental requirements (as well as others). This single integrated management system must be based firmly in the needs and values of the business itself. Then each new requirement that emerges can be carefully considered and integrated into the existing systems framework. Rather than implementing separate systems for managing quality and meeting environmental concerns, a company has a single business management system, which encompasses these areas and more. The overall goals and processes of the business don't change with each new initiative. Companies that are registered to ISO 9001 already have a head start. ISO 9001 requires many of the core system elements, which are common to any management system. The key is to make sure that these systems satisfy internal business needs as well as the external requirements, which are audited by the registrar. Systems which are non-value adding should be closely examined and improved so that they are beneficial to the business. The first step in implementing an environmental system is to conduct a gap analysis to determine which system elements are in place and which elements need to be improved or developed. Use ISO 14001 as a guideline or model of a comprehensive EMS. Examine the company's existing environmental systems, as well as quality systems, which could easily be expanded to include environmental elements. Based on the results of the gap analysis, determine the business' priorities for improving existing systems and developing new systems. There may be some systems, which exist in the quality system but are not currently applied to environmental systems. Typically, these systems can simply be expanded to include environmental elements. Document control is a good example. Prior to implementing ISO 9000, many companies had poor control of critical documents. In order to get registered to ISO 9001, a system is required to ensure that important quality-related documents are up-to-date and available where they are needed. The same system can be used to ensure that environmental documents are available and current. Begin by examining the existing document control system and assessing whether it will work effectively for environmental documents. Changes or improvements may be needed in the basic system. This is also a good time to evaluate the system's overall effectiveness. Is it simply defined and easy to use? Does it add to or detract from efficient business practices? Make any improvements that are needed and expand the system to include critical environmental documents. The degree of integration of the actual system may vary based on the unique needs and culture of the business. Some businesses may decide to completely integrate their document control system, creating a single list or database of critical business documents, whether related to quality or environmental, and applying identical controls. Other businesses may use separate databases or lists for environmental parameters but utilize the same general control procedures. Either way, the result is much more effective than creating a whole new system for employees to learn and use. Another example where ISO 9001 compliant systems can simply be expanded is internal auditing. Once again, the degree of integration could vary widely from one organization to another. A company could choose to use different auditors for EMS and quality auditing and conduct completely separate audits (using the same audit procedures). Alternatively, the same people could audit both systems (assuming the auditors are appropriately qualified) but audits could still be conducted separately. Finally, an organization could integrate the systems completely by conducting joint quality and EMS audits. Each organization should choose a system that will work most effectively within its own unique environment.

Critical EMS Elements

As noted earlier, complete system integration is not possible since each type of management system includes some unique elements. In an EMS, the most critical elements are those found in the Planning section of ISO 14001: environmental aspects, legal and other requirements, objectives and targets, and environmental management program. This sequence of planning activities, along with the environmental policy, forms the core framework for the EMS. ISO 14001 requires an organization to identify its environmental aspects -- those elements of its activities, products, or services which can interact with the environment -- which it can control and influence. Further, the organization must have a method of determining which of those aspects has or could have a significant impact on the environment. "Significant" is left

up to each organization to define for its own use. Satisfying this clause requires a thorough process for evaluating all of the varied elements of the business. It's easy to make some quick assumptions, but the most significant impacts may not be those that first come to mind. A chemical plant may already have excellent controls over its air emissions, water outflows, and waste management but could have a large fleet of vehicles for transporting its product which have never before been considered in an environmental sense. This process encourages companies to take a broad view of their environmental management systems. The standard also requires that a business identify all of the regulatory and other requirements which it must meet. "Other requirements" could include industry-specific programs or codes of practice, international agreements, and other voluntary programs to which the organization has chosen to comply. Examples include Responsible Care for the chemical industry and chemical distributors, the International Chamber of Commerce (ICC) Charter for Sustainable Development, and the Public Environmental Reporting Initiative (PERI). This means that the organization must treat these voluntary initiatives it has chosen just as it would comply legal or regulatory requirements. Based on the evaluation of significant impacts and identification of requirements, the organization must set specific environmental objectives and targets. These will be based on the organization's environmental policy and should be consistent with its business, financial, and operational policies. In an integrated business system, the environmental objectives and targets fit within the overall business goals; they don't describe a separate stand-alone system. Finally, the organization must have a systematic plan, or management program, to help it to meet each stated objective and target. The program must include defined responsibilities and timing. For example, a business could have an objective to reduce its energy usage, supported by a specific target to reduce energy consumption by a certain percentage over the previous year. The program for achieving this target could include detailed plans for improving operating efficiencies in the plant, working with the local utility company to reduce energy use during peak hours, and replacing a piece of old equipment with a newer, more energy efficient one. In this way, the program(s) support the objectives and targets which strengthens the overall policy, creating a framework for improving the environmental system. Although these planning elements are not included in this kind of detail in ISO 9001, there are some similar requirements to establish a quality policy and objectives and to use quality planning to define how the quality requirements will be met. Again, these system elements should be integrated to the degree that makes sense for a particular business. There may be a single overall business policy established which includes elements of both quality and environmental management. Larger or more complex businesses may prefer to maintain individual quality and environmental policies, but these should still be linked to an overall business policy and/or business mission. Similarly, an organization can define a basic process for setting objectives and targets and developing plans to meet them. That process can then be used for individual quality and environmental objectives. The exact format of these systems isn't critical. The key is to build a solid business system framework which encompasses all aspects of the company. In this way, the overall business philosophy and direction are clearly defined. Quality, environmental issues, and other aspects can be effectively managed as integral part of the overall business. The management systems are then focused on the needs of the business itself, rather than on the ISO standards. After all, ISO 9001 or ISO 14001 registrations won't mean much if the company can't make a profit and stay in business.

THE ILLUSION OF PLENTY

"Although 70% of the earth's surface is covered with water, around 97.5% of all water on earth is brackish. Of the 2.5% that is fresh, 70% is frozen in the polar ice caps. Most of the remainder is present as soil moisture or lies in the deep aquifers which are, within hydrological and economic limits, beyond our reach. Less than 1% of the earth's freshwater or about 0.007% of all water on earth is available, on sustainable basis, for our use".

Source : World Water Resources

AERATED LAGOONS: AN APPROPRIATE TREATMENT TECHNOLOGY FOR TANNERY WASTEWATER

By

Engr. Sajjad Haydar[1] and Dr. Javed Anwar Aziz[2]

ABSTRACT

Safe disposal of wastewater is the most critical environmental challenge facing Pakistan's leather industry. Among various treatment technologies available, aerated lagoons are considered best with respect to operational and cost stand point. Present study was undertaken with the objective to evaluate the performance of aerated lagoon for the treatment of tannery wastewater and formulate a design criterion for establishing treatment facilities for local tanneries. To meet these objectives, a bench scale model of aerated lagoon comprising of an aeration tank and secondary clarifier was used. It was operated continuously for 74 days by varying detention times from 3 to 9 days. Influent to aerated lagoon was the settled tannery wastewater. Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) tests were conducted on the influent to the aerated lagoon and effluent from the secondary clarifier for performance evaluation. The results of the study demonstrated that a detention time of 5 – 7 days in aerated lagoon is sufficient to render the effluent conform to National Environmental Quality Standards (NEQS) with respect to BOD. However, COD limit could not be satisfied even at a detention time of 9 days. For design purpose, food to microorganisms (F:M) ratio in the range of 0.27 to 0.44 per day is recommended on the basis of this study. Average value of overall BOD removal rate constant 'K' was found to be 1.43 day^{-1} at a mean reactor temperature of 30.2°C. The treatment technology also holds promise for common treatment plants under consideration for different tannery clusters located in the country.

1. INTRODUCTION

Leather is the second largest foreign exchange earning industry of Pakistan after textile sector. It earns a foreign exchange of US $ 715 million annually (EPB, 2004). The most critical environmental challenge facing Pakistan's leather industry is the safe disposal of wastewater, which requires major focus and calls for immediate attention and investment. There are over 596 tanneries in the formal sector and equally large number exist in the informal sector (Iqbal et. al., 1998). Major clusters of tanneries are located in Karachi, Kasur, Lahore, Sheikhupura, Gujranwala, Multan, Sialkot and Jahangira. For leather production locally available raw material (hides and skins) and imported process chemicals are normally used.

Tannery wastewater is highly polluted and the concentration level of some pollutants is many times beyond the limits set by the NEQS (PEPA, 1996). Most of the times tanning industries discharge their untreated effluent in the receiving water bodies. This practice has not only endangered human health but also affected aquatic life in the receiving waters.
Conscious to the implementation of ISO 14001 in year 2005, tanning industry is now striving for better environmental management to compete in the global market. Thus a rapid introduction of treatment facilities in tanneries, especially those which are export oriented, is envisaged. This trend is already in evidence. Construction of primary treatment facilities have been either completed or is under process in many tanneries (Iqbal et. al., 1998).

Biological methods are invariably employed for the secondary treatment of a large number of industrial wastewaters. A number of options are available for the purpose and include: activated sludge process (ASP); aerated lagoons (AL); and wastewater stabilization ponds (WSP), each with its merits and demerits. WSP involve minimal capital and operational

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cost but area requirement is overwhelming. ASP is expensive with respect to both capital and maintenance cost but requires less space. Furthermore, it entails skilled labour and proper laboratory facilities to control various operational parameters involved in running this process. The dilemma of local tanning industry is the lack of both these pre-requisites to operate this sophisticated process. This aspect emphasizes the need for installation of such facilities that involve little skilled labour and marginal laboratory work for quality control purposes.

Aerated lagoons in this regard, offer a low cost and appropriate technology for the secondary treatment of biodegradable wastewaters. It is widely employed due to its simplicity and design flexibility. Its advantages over ASP are: relatively lesser extent of operational control, higher shock absorption potential, effluent of consistent quality, lesser skilled labour and production of relatively more stabilized sludge. Extensive laboratory and pilot studies conducted during 1970-71 for the treatment of tannery wastewater showed that aerated lagoons were more desirable than activated sludge process from an operational and cost standpoint (Eye, 1974).

A new trend recently witnessed, is the construction of Common Treatment Plants (CTP) at tannery clusters in Pakistan. One such plant at Kasur has been completed and in operation. The plant comprises of wastewater stabilization ponds in series. The design of these ponds is not based upon bench or pilot scale studies. Therefore the facility is facing problems with respect to effluent quality and pond functioning. A CTP at Sialkot is also under consideration and rest of the clusters may also be taken up in future. Keeping in view these developments, present study was undertaken to assess the performance of aerated lagoons for the treatment of tannery wastewater and formulate design criteria to be used under local conditions.

2. MATERIALS AND METHODS

Experimental Setup:

In order to meet the objectives of the proposed research work, a bench scale model of aerated lagoon was used (Fig. 1). The model was made of perspex glass of 5 mm thickness. The wastewater to the model was fed using a 20-litre glass bottle. The detention time in aerated lagoon was varied from 3 to 9 days by regulating the flow rate with the help of a peristaltic pump. The capacity of the aerated lagoon was 36 litres. Diffuser stones were used to supply air and placed at the bottom of the lagoon along the wall. Filtered air was supplied to the diffuser stones from an air pump. A secondary clarifier (SC) of 4.2 litre capacity followed the aerated lagoon. The detention time in secondary clarifier varied from 8 to 25 hours as the detention time in aerated lagoon increased from 3 to 9 days.

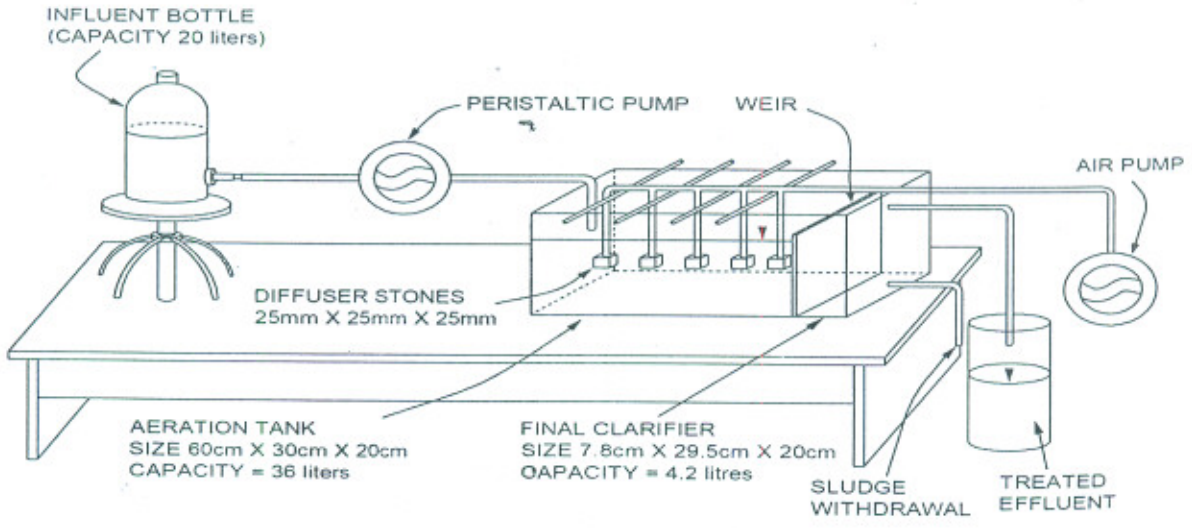


Fig. 1: Line Sketch of Bench Scale CSTR Without Recycle

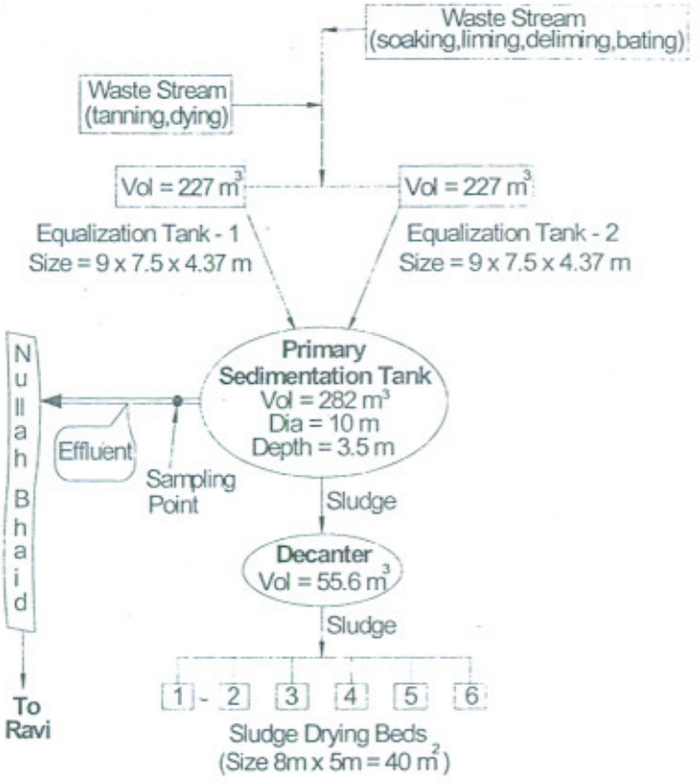


Fig. 2: Line Sketch of Primary Treatment Plant at Saddiq Leather Works

Wastewater

Wastewater samples for bench scale reactor were collected from Saddiq Leather Works (Pvt) Ltd, 12-Kilometer Lahore-Sheikhupura Road. The tannery is equipped with a primary treatment plant comprising of equalization tank, primary sedimentation tank (PST), decanter and sludge drying beds (Fig. 2). The detention times in equalization tank and PST at maximum wastewater flow of 1700 m^3/day are 6.4 hours and 3.9 hours respectively.

In tanneries, all the processes are carried out as batch operations and wastes originating thereof vary considerably in composition. Hence the wastewater samples were collected at the outlet point of PST to get reasonably homogeneous samples (Fig. 2). The pH of the samples collected from the tannery varied from 6.5 to 9 which showed that wastewater was reasonably equalized to achieve favourable pH range for biological treatment.

Nutrient Evaluation:

Total Kjeldahl Nitrogen (TKN) and Phosphorous (P) tests were carried out on the settled wastewater collected to check the level of nutrients for satisfactory biological treatment. The BOD : N : P for the wastewater came out to be 100:21:0.19 as against a required value of 100:5:1 (Benefield and Randall, 1980). The phosphorous was thus deficient. This deficiency was met by adding calculated amount of Potassium Dihydrogen Phosphate (KH_2PO_4) in the wastewater.

Reactor Operational Plan:

Bench scale reactor was started on 1.07.2003. After seeding it with domestic sewage, it was run as a batch system up to 4.07.2003 to develop biomass. Thereafter, it was run on a continuous basis till 12.09.2003. Complete operational schedule of the reactor is shown in Table 1.

Table 1: Operational Schedule of Bench Scale Reactor

Date		No. of Days	Flow Rate (L/day)	Detention Time (Days)
From	To			
1.07.2003	4.07.2003	4	-	-
5.07.2003	18.07.2003	14	9	4
19.07.2003	1.08.2003	14	7.2	5
2.08.2003	15.08.2003	14	5.14	7
16.08.2003	6.09.2003	18	4	9
3.09.2003	12.09.2003	10	12	3
	Total	74		

Tests Conducted:

Samples from the influent to the reactor and treated effluent from the secondary clarifier were simultaneously collected to carry out pH, temperature, BOD and COD determinations. Mean values of BOD and COD were used to find out efficiency of aerated lagoon. Samples from the reactor were collected on daily basis to find out temperature, pH, dissolved oxygen (DO) and mixed liquor suspended solids (MLSS). These tests were utilized to ensure favourable environmental conditions in the reactor for biological treatment. All tests were carried out as per procedure laid down in the "Standard Methods for the Examination of Water and Wastewater".

3. RESULTS AND DISCUSSION

Performance of Aerated Lagoon:

Performance studies and formulation of design criteria were carried out by varying detention time in aerated lagoon from 3 to 9 days. Parameters selected for this purpose were BOD and COD. Removal efficiencies for BOD and COD corresponding to various detention times in aerated lagoon are shown in Table 2 and 3, respectively.

Table 2: Percentage Removal of BOD Vs Detention Time

Detention Time (days)	BOD (mg/L) Inf		Eff		% Removal (Mean)
	Range	Mean	Range	Mean	
3	(482-615)	550	(71-125)	97	82.36
4	(435-593)	514	(65-110)	84	83.66
5	(416-529)	480	(53-81)	67	86.04
7	(442-610)	525	(29-53)	39	92.57
9	(433-549)	496	(20-39)	29	94.16

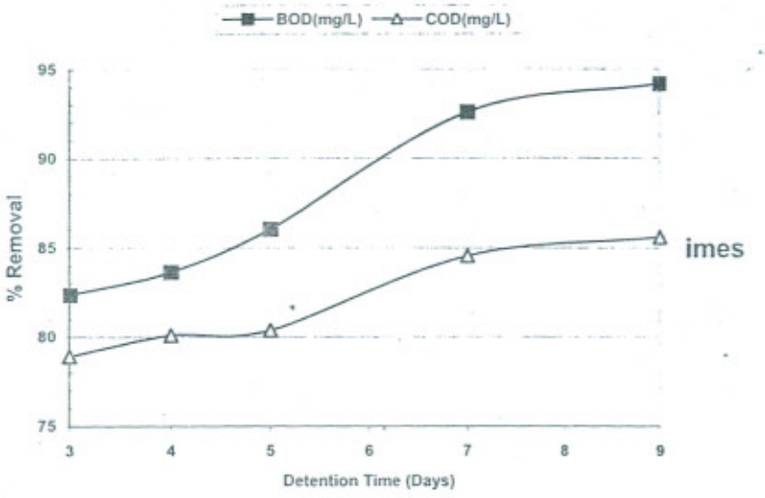
Table 3: Percentage Removal of COD Vs Detention Time

Detention Time (days)	COD (mg/L) Inf		Eff		% Removal (Mean)
	Range	Mean	Range	Mean	
3	(1280-1820)	1570	(288-332)	331	78.92
4	(1160-1600)	1362	(252-300)	271	80.1
5	(980-1420)	1253	(220-272)	246	80.37
7	(1220-1760)	1457	(216-244)	225	84.56
9	(1080-1480)	1297	(176-204)	187	85.58

Table 2 shows that NEQS limit for BOD (80 mg/L) was satisfied at a detention time of 5 days. Therefore, a detention time of 5-7 days in aerated lagoon seems to be quite suitable to satisfy the effluent quality with respect to BOD.

Table 3 shows that NEQS limit for COD (150 mg/L) could not be satisfied even at a detention time of 9 days. However, significant improvement in removal rates could be observed

between detention times of 5-7 days. Owing to large quantities of non-biodegradable organic matter in tannery wastewater, the NEQS limit of 150 mg/L seems to be stringent and must be revised. Performance of bench scale aerated lagoon for BOD and COD is graphed in Fig.3.



Food to Microorganisms (F:M) Ratio.

Food corresponds to influent BOD or COD and microorganisms correspond to MLSS of aerated lagoon. F:M ratio can be used as a design parameter for aerated lagoons (Benefield and Randall, 1980). Therefore, it was determined for both BOD and COD along with corresponding removal efficiencies from the available data as shown in Tables 4 & 5, respectively.

Table 4: F:M ratios for BOD and Removal Efficiency

Detention Time (days)	Mean Influent BOD (mg/L)	Mean MLSS (mg/L)	F:M Ratio (day^{-1})	% Removal
3	550	297	0.62	82.36
4	513	260	0.49	83.66
5	480	217	0.44	86.04
7	525	279	0.27	92.57
9	496	308	0.18	94.16

Table 5: F:M ratios for COD and Removal Efficiency

Detention Time (days)	Mean Influent COD (mg/L)	Mean MLSS (mg/L)	F:M Ratio (day^{-1})	% Removal
3	1570	297	0.33	78.92
4	1362	260	0.25	80.10
5	1253	217	0.20	80.37
7	1456	279	0.14	84.56
9	1296	308	0.11	85.58

Results for F:M ratio and corresponding removal efficiencies for tannery wastewater were not comparable due to non-availability of local data from other similar works. These values are useful for designers for the selection of an appropriate F:M ratio while targeting for a particular removal efficiency.

Overall BOD Removal Rate Constant

An alternative approach for the design of aerated lagoons can be adopted by using the following design equation (Metcalf and Eddy, 1991)

$$\frac{S}{S_o} = \frac{1}{1+Kt} \quad \text{.....(1)}$$

Where

S_o = Influent BOD, mg/L
S = Effluent BOD, mg/L
K = Overall BOD removal rate constant, day^{-1}
t = Detention time in aerated lagoon, days

Thus if S_o is known and S is fixed for a particular treatment facility, the required detention time (t) for the aerated lagoon can be obtained provided 'K' for the specific wastewater is known. The data obtained during the present study were used to find the average value of 'K' for tannery wastewater (Fig. 4). The slope of the linear regression line fitted to the plotted data gave the value of 'K' as 1.43 day^{-1} at a mean reactor temperature of 30.2°C. The reported value of 'K' varies from 0.5 to 1.5 day^{-1} (Metcalf and Eddy, 2003). Thus the results obtained were in line with the available literature.

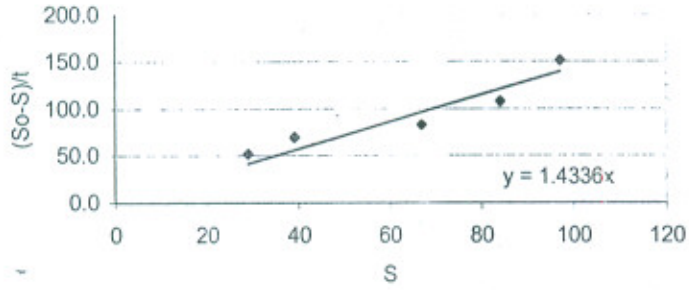


Fig. 4: Determination of 'K'

It must be noted that 'K' is temperature dependent and following Arrhenius equation is usually used to find out the value of the coefficient at other temperatures.

$$K_2 = K_1 (\theta)^{T2-T1} \quad \text{.....(2)}$$

Where

K_1 = Reaction rate constant at temperature T_1
K_2 = Reaction rate constant at temperature T_2
T_1, T_2 = Temperature, °C
θ = A constant

The value of θ has been found to vary from 1.056 in the temperature range between 20 to 30 °C to 1.135 in the temperature range between 4 and 20 °C (Schroepfer, 1964). However, a value of θ often quoted in the literature is 1.047 (Metcalf and Eddy, 2003).

COD and BOD Relationship:

COD and BOD ratios for both influent and effluent were determined to establish a relationship between two parameters. The COD/BOD ratio on the basis of collected data for influent came out to be 2.7 as shown in Table 6.

Table 6: Mean COD/BOD ratio for Influent

No. of Readings	COD (mg/L)		BOD (mg/L)		Average
	Range	Mean	Range	Mean	
29	980-1820	1382	416-615	512	2.7

The correlation, between the two parameters for influent was found out by plotting data for influent COD and BOD and fitting a linear regression line to the plotted data as shown in Fig. 5 (Aziz, 1978). The correlation came out to be

$$BOD = 0.25\ COD + 166 \quad \text{.....(3)}$$

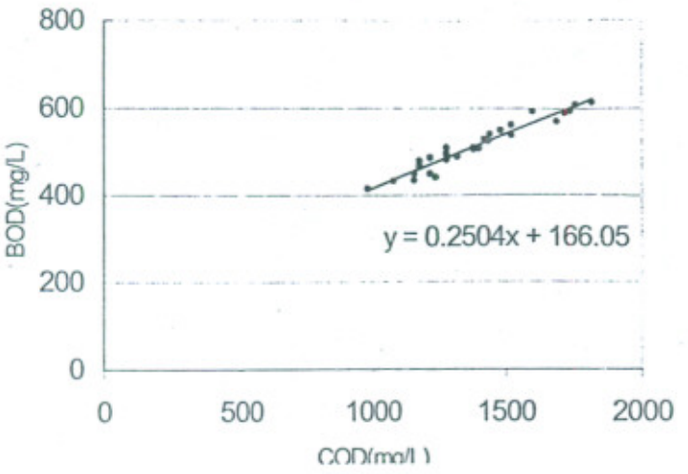


Fig.5 : Relationship Between Influent COD and BOD

It may, therefore, be concluded that a reasonably good approximation of BOD can be obtained from a COD measurement once a relationship has been established between the two parameters from the available data. However equation (3) must be used with caution. A substitution of 'zero' for COD in the said equation yields a value of 166 mg/L for BOD, which is not possible. Its application is, therefore, restricted and valid only for the present waste when COD falls in a range of 980-1820 mg/L (Table 6).

COD and BOD ratios for effluent from secondary clarifier are presented in Table 7.

Table 7: Mean COD and BOD Ratios for Effluent

Detention Time (days)	Effluent COD (mean) (mg/L)	Effluent BOD (mean) (mg/L)	COD/BOD
3	310	97	3.1
4	272	84	3.2
5	246	67	3.6
7	225	39	5.7
9	187	29	6.4

Two things are evident from Table 7. Firstly, COD/BOD ratios for effluent were more than that for the influent (2.7). This is due to the removal of biodegradable matter in the aerated lagoon. Secondly, COD/BOD ratio increased (from 3.1 to 6.4) with a corresponding increase in detention time from 3 to 9 days. This was obvious as more biodegradable matter was consumed with increase in detention times and non-biodegradable remained to give higher COD/BOD ratios.

During the course of the study, the reactor temperature fluctuated between 29 to 31°C, which falls within the suitable temperature range for heterotrophic bacteria treating wastewater under aerobic conditions (Doetsch and Cook, 1973). The pH of the reactor remained between 6.5 and 8.0, which is a suitable range for biological treatment (Willkison, 1975; Benefield and Randall, 1980).

DO of the reactor remained between 3 and 4.5 mg/L, which was above the desirable range of 2 mg/L for biological treatment (Porges, 1953; Richard and Gaudy, 1968; Parker and Merril, 1976; Benefield and Randall, 1980).

CONCLUSIONS

Following conclusions can be drawn based upon the results of the present study.

1. Treatment of tannery wastewater through equalization, primary sedimentation, aerated lagoon and secondary clarifier holds promise to affect the desired removals with respect to BOD. With a detention time of 5 – 7 days in aerated lagoon, such system resulted in an average effluent BOD of 67-39 mg/L, which qualify NEQS. No significant BOD removals were observed beyond a detention time of 7 days.
2. An average value of 2.7 for COD/BOD ratio for influent to the bench scale aerated lagoon clearly indicates that a large portion of organic matter in tannery wastewater was not easily biodegradable.
3. Average value of overall BOD removal rate constant 'K' for settled tannery wastewater was found to be 1.43 day^{-1}. It includes both soluble and particulate BOD.
4. COD limit of 150 mg/L as per NEQS could not be satisfied even at a detention time of 9-days (187 mg/L). Owing to large quantities of non-biodegradable matter in tannery wastewater, the 150 mg/L standard for COD seems to be stringent and must be revised for specific wastewaters having large quantities of non-biodegradable organic wastes.

RECOMMENDATIONS

Following recommendations are made in the light of the present study:

1. Equalization tank followed by a primary sedimentation tank should form an integral part of the wastewater treatment system for tanneries. It evens out shock loads that are in the form of pH, temperature or BOD, resulting in better performance of biological units.
2. A detention time of 5-7 days in aerated lagoon is recommended for prototype facilities.
3. F:M ratio in the range of 0.27 to 0.44 per day is recommended for the treatment of tannery wastewater to conform to NEQS with respect to BOD.
4. It is recommended to build common treatment plants for the tannery clusters located in Sialkot, Sheikhupura, Gujranwala, Multan and Jahangira using aerated lagoons. The experience with facultative ponds at the common treatment plant of Kasur tannery cluster has proved problematic with respect to quality of the effluent and operation of ponds. The CTP at Sialkot, which is in planning phase, may employ aerated lagoons on the basis of present study.

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THE DOUBLIN PRINCIPLES

1. Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels.
3. Women play a central role in the provision, management and safeguarding of water.
4. Water has an economic value and should be recognized as an economic good.

"Water is the source of life yet is too often a source of conflict. There are more than 260 trans-boundary rivers in the world. The risk of conflicts will grow in proportion to the depletion of water resources".

Source : World Water Council

DEVELOPMENT OF SEMI-SOLID PROCESSED ALUMINUM CAST ALLOYS BY INCLINED COOLING PLATE TECHNIQUE

By

Engr. Nasir Hayat*

Abstract

Use of aluminum cast alloys is increasing in structural applications. However, there is a need for improvement in the mechanical properties for advanced applications such as aerospace. The rheocasting can be helpful in controlling the microstructure and thus improving mechanical properties. Traditionally employed rheocasting techniques are expensive due to the nature of the equipment involved. This paper explores the application of an economical technique based on inclined cooling plate for producing semi-solid aluminum cast alloys. The grain size was reduced along with the spheroidization of eutectic Si and intermetallic compound particles by employing inclined cooling technique. Tensile properties are improved as compared to the squeeze cast aluminum alloys.

Introduction

Rheocasting process employing an inclined cooling plate technique is used to produce semi-solid slurries with spherical microstructures. It was introduced by Motegi et al. [1] in Japan and was developed on the basis of crystal separation theory [2]. According to crystal separation theory, granular crystals nucleate and grow on the mold wall and then are separated from there by fluid motion until stable shell forms on the mold wall [2]. Inclined cooling plate is simple and economical when compared with the thixocasting as well as other rheocasting techniques.

Due to these advantages it is becoming the focus of intensive research, though with slightly different names of cooling slope in U.K. [3] and cooling channel in Germany [4]. In rheocasting process, employing an inclined cooling plate technique, alloy melt is poured on the cooling plate, which causes nucleation of many seeds of primary μ during the flow of alloy on it. Thus due to the flow over cooling plate, alloy melt becomes semi-solid slurry with seeds of primary μ dispersed in it everywhere before reaching the mold for final shaping operation. However, the process as described above is too simple and there are several parameters, which need careful selection for successful implementation of this process. These are as follows:

1) Efficiency of inclined cooling plate in nucleating seeds of primary μμ
2) Only nucleation of primary μ seeds takes place on inclined cooling plate. If so, then where growth and globularization take place?
3) Factors affecting nucleation and its rate e.g. temperature of alloy melt, temperature and material of cooling plate, pouring rate of alloy melt and etc.
4) Factors affecting growth and its rate e.g. material of die, holding time and temperature, if any, before pressing, temperature of die, temperature and material of plunger and etc.
5) Effects of environment like oxidation of alloy melt.
6) Other factors like plunger speed and pressure applied, sticking of alloy melt to cooling plate, material loss and etc.
7) Factors affecting the rate of solidification. Volume fraction of solid (due to particular combination of alloy melt temperature, flow length and etc.) and its relationship with the mechanical properties of the produced material and macrosegregation.

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8) Effect of alloy melt flow on cooling plate, if any, on other microstructural features like eutectic Si and intermetallic compound particles.

As a result of research so far, answers to some of the questions raised above have been clarified, while in other cases, some contradictions and ambiguities still exist. The main ambiguity is regarding the mechanism of globularization. According to some reports [1, 4], globularization takes place during isothermal holding/decelerated cooling after the alloy melt has left the cooling plate with numerous seeds of primary μ. Moreover, holding time and temperature is not clear from these reports. However, the experience of the author shows that with a suitable combination of alloy melt temperature and flow length, nucleation and globularization takes place simultaneously. And, isothermal holding of semi-solid alloy melt leads to the increase in size of already sufficiently grown primary μ. This is the reason that semi-solid alloy melt was immediately pressed after pouring into the mold during this study. This practice not only eliminated the need for isothermal holding system but also gave the materials with desired μ sizes. Another issue is about the spheriodization of eutectic Si. According to Haga et al. eutectic Si is equally spheriodized during different conditions of alloy-melt temperature and flow length [3]. However, the experience of author shows that spheriodization of eutectic Si varies with the change in size of primary μ. This fact is important as euetctic Si is known to affect the ductility of cast aluminum alloys. Yet another important ambiguity is about rate of solid generation and amount of solid fraction. For nearly equal alloy-melt and flow length, the reported values of solid fraction range from 0.4 to 0.7 [1, 5].

Keeping in view the facts mentioned above, it was decided to undertake a systematic research focusing on microstructural features of rheocast materials fabricated by employing inclined cooling plate technique. To accomplish this task, materials with three μ sizes (i.e. 38 m, 82 m, 160 m) are prepared by the inclined cooling plate technique similar to that of Motegi et al. [1]. For the purpose of comparison, a squeeze cast material is also prepared.

Material and apparatus

In the present study a hypoeutectic Al-Si alloy (designated as AC4CH in the Japanese Industrial Standards) was used. The chemical composition of the alloy is shown in Table1.

Table 1 Chemical composition of AC4CH alloy (mass%)

Si	Mg	Fe	Ti	Mn	Zn	Al
7.0	0.32	0.10	0.12	0.06	0.04	bal.

Figure 1 shows the schematic diagram of inclined cooling plate employed in the present study. In this method, alloy melt is poured on a cooling plate. Many seeds of primary μ are formed during the flow on the cooling plate before leaving the plate and entering a mold. In this way the globularization of the primary μ phase is accomplished. The alloy was melted in an electric furnace and held at 1023K for 30 minutes. A K-type thermocouple was used to monitor the temperature. The alloy melt was cooled slightly to a previously determined temperature and then poured on the inclined cooling plate, which led it to a steel mold for casting. The mold was held at 573K using an electric heater. The inclined cooling plate was made of copper with channels for cooling water on its back. Immediately after pouring into the die the semi-solid melt was pressed under a uniaxial pressure of 100MPa with a plunger speed of 39 mm/sec and cylindrical ingots having a diameter of 60 mm and length of 30 mm were obtained. Primary μ size was controlled by changing the temperature of the melt and length of the flow on the inclined plate by varying the inclination angle. In this way, primary μ sizes of 38 m and 82μm were obtained with the combinations of 903K/300mm and 913K/200mm respectively. To obtain the material with higher μ size the same casting conditions as those of 82μm were used.

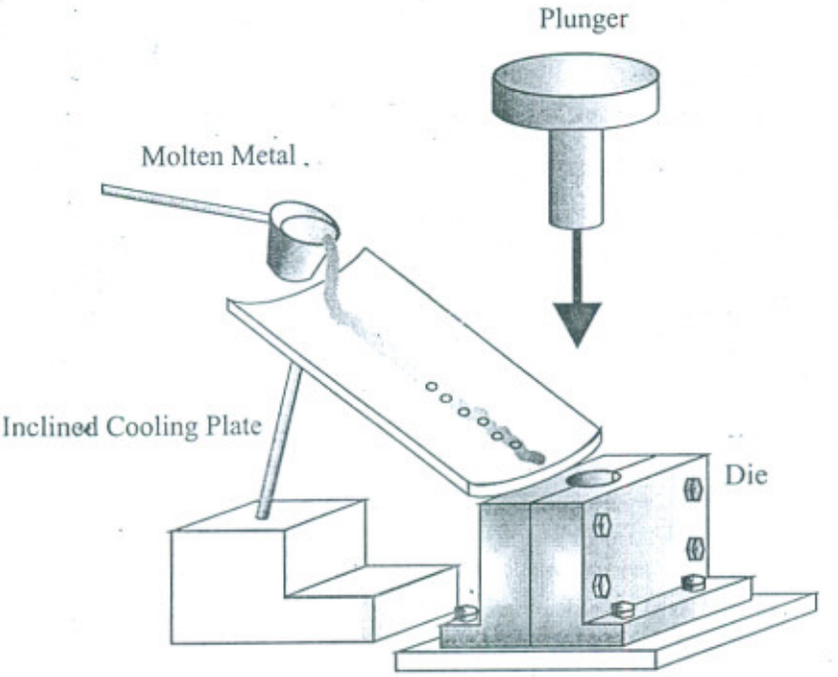


Fig.1 Schematic diagram inclined cooling plate

However, before pressing, the semi-solid melt was held in a crucible immersed in a salt bath at 973K for 350 seconds. μ reached about 160 m in this way. The same mold and casting conditions were used for both the semi-solid and squeeze casting, however, in the case of the squeeze casting melt at 973K was directly poured into the mold without using the inclined cooling plate. All the four types of materials were solution heat-treated for 28.8 ks at 880K and then artificially aged for 21.6 ks at 443K to reach the T6 temper condition. Fig. 2 shows the schematic illustration of the heat treatment process.

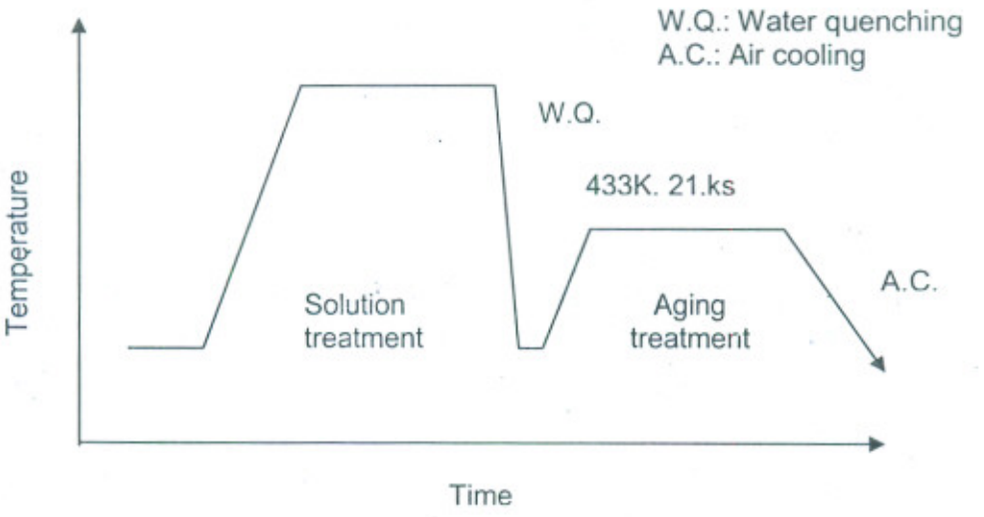


Fig.2 Schematic illustration of the heat treatment process

Microstructural observations

To reveal grain structures of the as-cast materials, rectangular samples were cut along the longitudinal direction and polished until the surface became like a mirror. Then samples were anodized using the Barker's reagent (HBF: 4% and H_2O: 96%) at 20V for 45 seconds. After this optical observations were made under polarized light. A scanning electron microscope (SEM) coupled with a digitizer was used to quantify the size of primary μ degree of

spheroidization, sizes and aspect ratios of Si particles and intermetallic compound particles, grain size of the matrix and etc. The degree of spheoridization can be calculated from the following equation:

$$F(s) = \frac{P^2}{4\pi A} \times 100$$

where P is peripheral length and A is cross section of primary μ For completely round-shaped particles, F(s) is equal to 100.

Experimental procedures

Micro Vickers hardness test

Micro Vickers hardness of the as cast and the T6 tempered specimens was determined under a load of 0.098N for 15 seconds to compare the primary μ and eutectic regions.

Tensile test

Tensile specimens were machined from ingots according to JIS 2201 [6] so that the gage lengths were perpendicular to the axial direction along which pressure was applied during casting. Gage length of each specimen was polished and strain gage was attached to it. Testing was carried out on a universal testing machine (Instron: model 5583) at a loading rate of 8.3×10^{-6} in air at room temperature.

Experimental results and discussions

Microstructural observations

Table 2 lists the measured microstructural parameters such as the average μ size, shape factor, grain size and secondary dendrite arm spacing. It is clear from this Table that the μ size could be successfully varied from 38 m to 160 m in this study. As compared to the μ size values, e.g. 60 m reported by Iwazawa et al. [7], 55 m to 200 m reported by Okano [8] and 52 m to 120 m reported by Jung et al. [9], the minimum μ size (i.e. 38 m) in the present study is small enough and can be used to evaluate a potential upper limit for the mechanical performance of the materials with spherical primary μ phase. This Table also includes microstructural parameters about eutectic Si and intermetallic compound particles. Average eutectic Si size becomes smaller with the spheroidization and reduction in size of μ. Aspect ratio also decreases with the decrease in μ size resulting in the minimum internal stress with the minimum μ size. The intermetallic compound particles are mainly $FeSiAl_5$ in this study and show a similar trend to that of eutectic Si.

Table 2. Various microstructural parameters

	Aluminum Matrix				Eutectic Si		Intermetallic compound
	Mean α size (um)	Shape Factor F(s)	Grain Size (um)	SDAS (um)	Si Size (um)	Aspect ratio	Mean size (um)
Rheocasting (α =38um)	38.2	145.6	162.8	----	2.8	1.7	1.7
Rheocasting (α =82um)	81.2	140.8	293.3	----	4.2	2.4	1.9
Rheocasting (α=160um)	159.7	140.4	348.5	----	5.6	2.9	4.9
Squeeze cast	----	----	538.0	23.3	8.7	6.3	2.6

Figure 3 shows typical optical micrographs of the solidification structures and grain structures under polarized light by using Barker's method respectively. It can be seen that the squeeze cast material is dendritic whereas the rheocast materials have spherical

microstructures. There was no evidence of any considerable fabrication defects like pores in the squeeze cast material and entrapped eutectic region in primary μ phase in the rheocast materials. The grain size of the rheocast materials is approximately 1/3 to 2/3 of that of the squeeze cast material. In the squeeze cast material, one grain consists of several dendrites, on the other hand, in the rheocast material about 10 primary μ particles, all aligned in the same direction to form one grain.

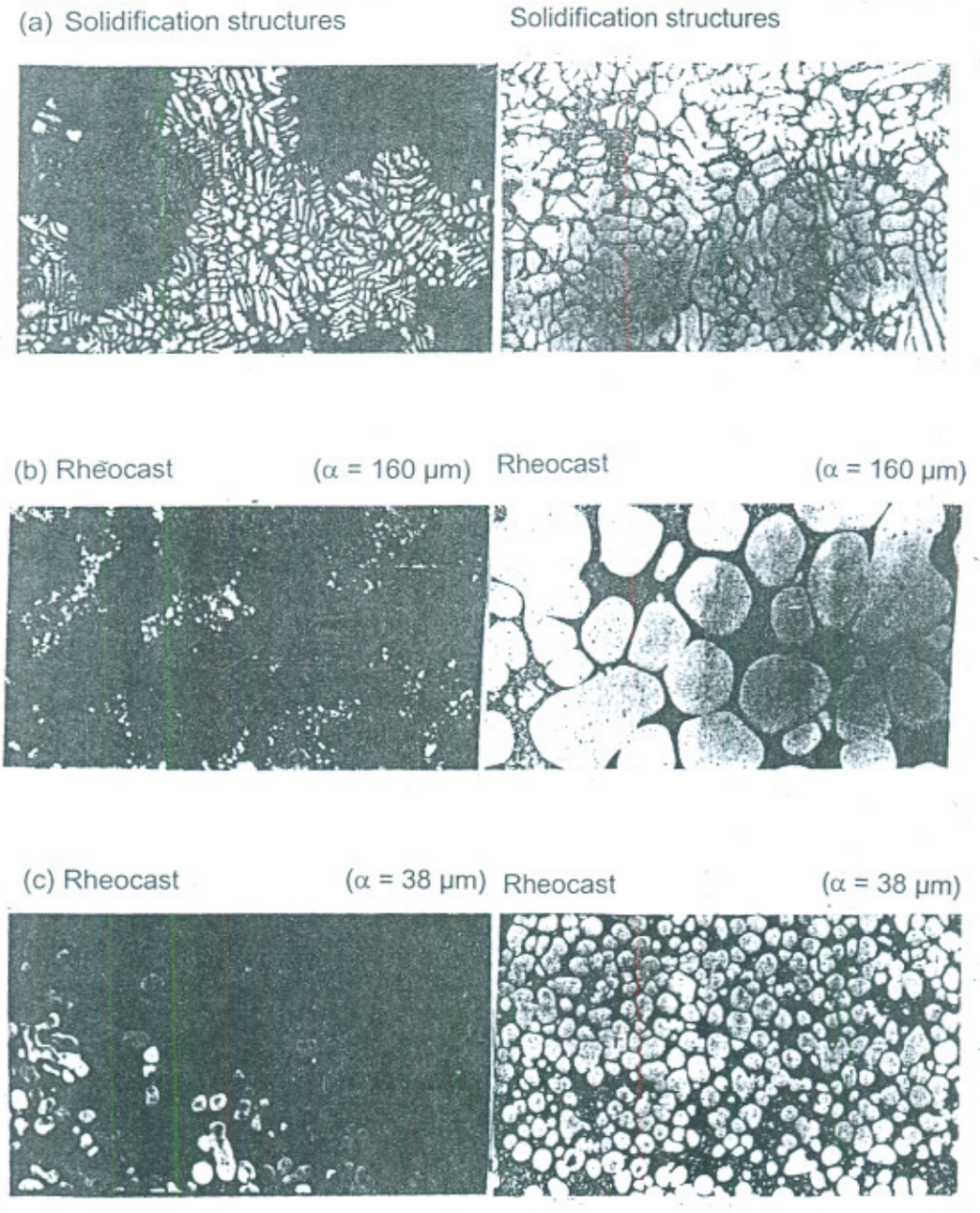


Fig. 3 Optical micrographs (X400) of solidification structures and grain structures under polarized light

Tensile properties

Figure 4 shows the results of the tensile tests. Tensile and yield strengths of the squeeze cast and rheocast materials with μ of 82μ m are comparable, however, the squeeze cast material outperforms the rheocast materials in the case of elongation. Tensile strength, yield strength and elongation of the finest rheocast material (i.e.38 m) are +7.3%, 11.7% and –3.5% higher as compared to the squeeze cast material

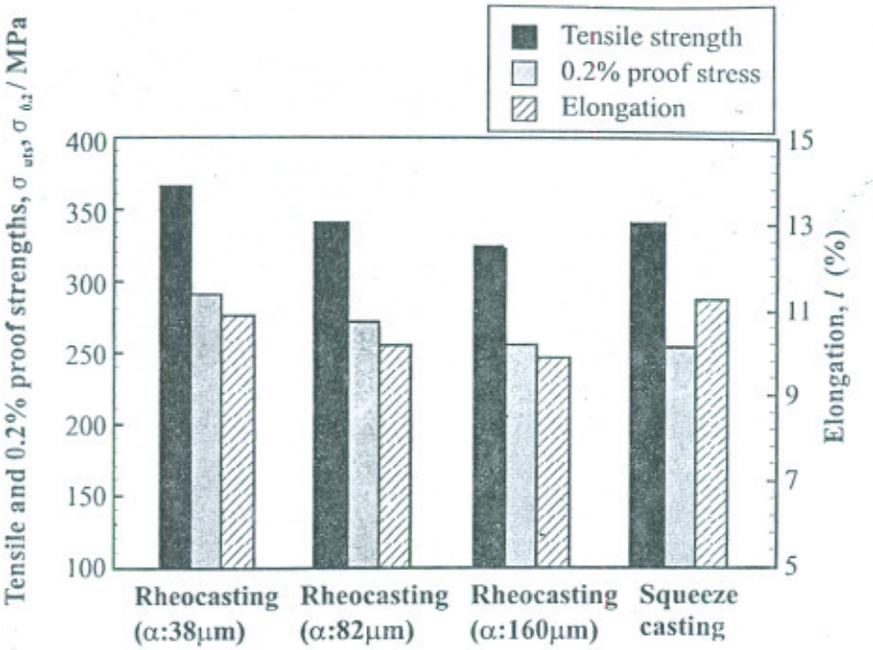


Fig. 4 Result of Tensile Tests

Hardness

Figure 5 represents the results of micro Vickers hardness tests in the μ phase for both the as cast and the T6-tempered materials. There is no noticeable difference in the hardness of all of the as-cast materials whereas the T6-tempered rheocast materials have higher hardness as compared to the squeeze cast material especially in the case of lower μ size and the hardness increases with the decrease in size of primary μ. he rheocast material has higher hardness than that of the squeeze cast material is similar to the results of Iwazawa et al [7]. It means that the solution treatment increases the supersaturation.

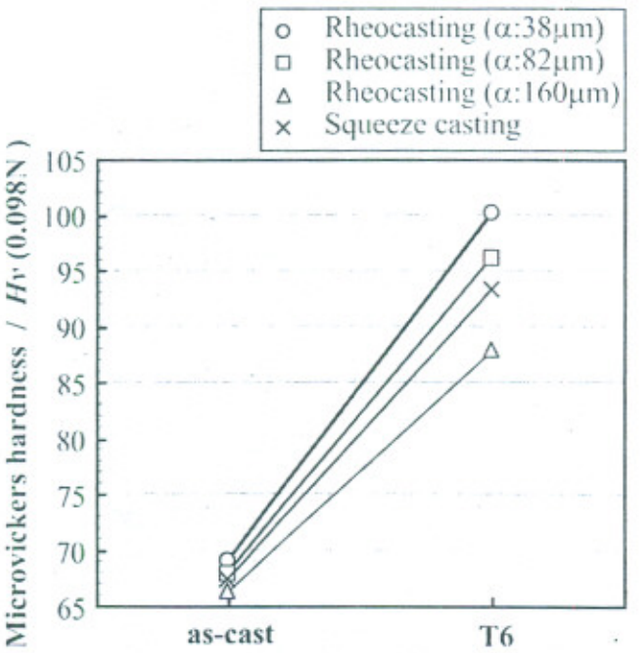


Fig. 5 Microvickers hardness measured in primary α phase

Conclusions

Semi-solid processed aluminum cast alloys with improved mechanical properties have been developed with an economical inclined cooling plate technique. The results can be summarized as follows:

1) Semi-solid processed aluminum cast alloys can be economically developed through inclined cooling plate technique.

2) The primary α size could be controlled by controlling casting conditions i.e. nucleation rate

3) With the decrease in α size, there is improvement in mechanical properties.

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OBITUARIES

May their souls rest in Peace

1. Engr. Mian Muhammad Manzoor (Retd.) G. M. (West) WAPDA passed away on 5.11.2004
2. Mrs. Fazeelat Arshad, sister of Engr. Muhammad Naeem Chughtai C. E. Building Department (South Zone) Punjab & Member Executive Council, P. E. C.
3. Engr. Aleem Khan S. E. (C & W) Department Punjab Lahore.

Views from Abroad

SHOULD KALABAGH DAM ON RIVER INDUS BE BUILT ?

By

Dr. G. S. Dhillon*

The "Window on Pakistan" column published by the Tribune regularly, provides interesting information as to what is happening on the other side of the Wagah Border. In the issue of the Tribune dated 21.09.2003, Shri Gobind Thukral wrote about ongoing debate in Pakistan on the above topic. As the development in the Indus Basin is also interest to other 'Share Holders' of waters of the Indus Basin, so an attempt has been made to answer the above question.

WATER RESOURCE ALLOCATION AND UTILISATION BY PAKISTAN

As result of the Indus Water Treaty of 1960, Pakistan got full right to utilise the water of the three western rivers of Indus Basin amounting to 144 MAF (Million Acre Foot) out of the total flow of 177 MAF. As per information available, the average annual utilisation (1947-2002) is 105 MAF. Pakistan became as Independent Sovereign State on 14.08.1947 and at that time the average annual utilisation were 64 MAF.

At present Pakistan does not have any control of over as MAF of water which flows waste to sea.

Question arises that should we let so much flow to the sea in the interest of preserving the eco-system's balance ?

WATER NEEDS OF AREA LOCATED ON THE LEFT OF THE RIVER INDUS

The Sind Sagar Doab, the area lying between the rivers of Indus and Jhelum, has the first right to use of the Indus waters as per riparian principle ? This was recognised and in 1873, the case for canal water supply to the area was considered. To take care of the development and to obtain funds, the Sind Sagar Colonisation Act was passed in 1901. This act entitled the government to take over ¼th of the land to be covered by canal irrigation, in lieu of 'bringing canal water' to the area or the 'betterment levy'.

Rectangular Survey of the area was carried out in 1916 and suitable site for the head-works decided. It was proposed to off-take a canal called the Thal Canal frcm the left bank to irrigate part of the Sind Sagar Doab. In 1912, a detailed project report of the Kalabagh Barrage came to be prepared and the full supply discharge of the Thal Canal was fixed as 14,000 cusecs. But the case was 'shelved' as the work on the Sutlej Valley project (SVP) was on and that was assigned 'higher priority'.

However, in 1912, the Project was taken up for reconsideration and a detailed project was prepared and submitted to the Government. In this Project Report, the capacity of the Canal was no different and for the same reason as before the Project was 'shelved'.

But in 1925, the Project was taken up and it was decided to lower the capacity of the Thal Canal to 6750 cusecs. It was also decided to study the 'impact of building the Sukkar Barrage' on the withdrawals from the river Indus upstream of the Sukkar Barrage. The Sukkar Barrage was sanctioned in 1923 and the Sukkar Barrage was completed during 1932.

In 1935, the Anderson Water Distribution Committee was set up for 'establishing a basis for equitable distribution of water in the Indus Basin' and this Commission allocated 6000 cusecs water for the Thal Canal and also placed a restriction of 2000 cusecs on the water to be used in rabi or winter season.

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Based on the above, a new project was prepared in 1936, but this project was once again assigned a lower priority i.e. put on the "Waiting List".

After all this, in 1940, the project was approved, fixing the maximum capacity of the Thal Canal as 10,000 cusecs as more data had become available justifying the increase in the capacity fixed by the Anderson Committee. The maximum area to be irrigated lay in the tehsils of Khushab and Western Thal. By 1947, a small portion of the Main Line and the Mujhar Branch was ready and its commissioning ceremony (The Thal Project) was done by Sir Evan Jenkins, the then Governor of Punjab.

When Pakistan came to be formed in August 1947, the above project acquired urgency, as large number of 'refugees' were to be rehabilitated in the Sind Sagar Doab area. By the year 1955, some 33742 families were settled and for them 640 new villages were set up. The area allotted to these families was around 4.5 lakh acres. The maximum withdrawals in the rabi were raised to 3000 cusecs. The Thal Canal was constructed in 1974 and its capacity now is 10,000 cusecs.

BUILDING OF CHASHMA BARRAGE

During the building of the Indus Treaty Works, i.e. Link Canals and the storage Dams, it was decided to build link from the river Indus of 22,000 cusecs and for that remodel the Kalabagh Barrage. But as it was found that it would not be possible to remodel this barrage, it was decided to build another Barrage called the Chashma Barrage, located some distance below Kalabagh Barrage. In order to meet then level requirements of the Link Canal, the pond level was required to be raised by 7 ft. providing a live storage of 0.5 MAF. Also C/J link was constructed to provide water to the lower part of the Bahawalpur State which earlier depended on Sutlej flows.

BUILDING OF TARBELA DAM

As a part of the Treaty Works, 470 ft. high earthen dam was built in just six years time which provided a 'live storage' of 9.7 MAF. This dam was commissioned in 1974.

Till December 2002, 3.03 MAF silt has got deposited in the Tarbela Dam Storage, which gives a loss of storage of 26%. By the year 2010, storage loss would be around 34% (3.951 MAF).

The Expert's assessment put the loss of storage by the year 2025 at 77% unless some remedial measures are taken. The Datt would then lose its utility as the deposited silt 'would block the tunnel intakes'. So the Experts have suggested the building of a check Dam at Bhasha.

So the efforts should be made to build more 'live storage' on the river Indus.

BUILDING DAM AT KALABAGH SITE

A suitable site is available some 16 miles upstream of the Kalabagh Barrage, also known as Jinnah Barrage. The Kalabagh Dam is under consideration of the Government of Pakistan and will be taken up as soon as decision is announced.

IN CONCLUDING

It may be stated that there is no justification for the continued wastage of some 35 MAF flow to sea, of the river Indus water, particularly when the Sind Sagar Doab is "Clamouring" for water.

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