International Fertilizer Industry Association

IFA Technical Conference

Amman, Jordan
2-6 October 1994

International Fertilizer Industry Association - Secretariat: 28 rue Marbeuf - 75008 Paris - France
Tel. +33 1 53 93 05 00 - Fax +33 1 53 93 05 45/47 - ifa@fertilizer.org - www.fertilizer.org

EFFECTIVE MAINTENANCE TECHNIQUES FOR HIGHER PRODUCTIVITY AT IFFCO'S KANDLA UNIT

T.S. Bhinder
IFFCO, India

RESUME

L'unité de Kandla d'Indian Farmers Fertiliser Cooperative Limited a une capacité théorique de 260 000 t/an de P_2O_5. Les principaux produits sont NPK 10:26:26, NPK 12:36:16 et DAP 18:46:0. L'unité a enregistré une moyenne de 300 j de fonctionnement par an. Ceci est dû à une technique systématique et efficace de maintenance appliquée.

L'exposé décrit le système de maintenance : routine, prévention, prévision, réparation des pannes et le système employé pour garder trace du capital/remplacement/modification et stocks des pièces de rechange. L'histoire de cas des réalisations techniques de maintenance sera soulignée.

◆ ◆ ◆ ◆

1. MAINTENANCE ORGANISATION

In order to achieve the above objective, the Maintenance Department has been organised in a scientific manner by suitably dividing the complete plant area into sub-units. The Maintenance Department is headed by Chief Manager (Maintenance), who is placed in the organisational chart at par with Production and other functions. He reports to the General Manager (Head of the Unit)/Joint General Manager. The Chief Manager (Maintenance) leads a team of qualified and experienced mechanical, electrical, instrumentation and civil engineers and craftsmen.

2. MAINTENANCE SYSTEM

The maintenance system followed at IFFCO Kandla is a suitable combination of following practices:

2.1. Routine Maintenance
2.2. Preventive Maintenance
2.3. Predictive Maintenance
2.4. Breakdown Maintenance
2.5. Capital Replacements/Modifications

2.1. ROUTINE MAINTENANCE

The total plant is divided into sub-maintenance units like NPK Plant, Offsites & Utilities and Bagging, Workshop, etc. The routine maintenance is carried out by maintenance shift/general shift staff under the guidance of the Group Maintenance Engineer. Routine maintenance as it means is carrying out minor maintenace works at regular frequency. This covers the activities like cleaning, lubrication, minor adjustments, tightening of loose parts like bearing block bolts, making free the conveyor roller by taping at site, aligning all conveyor belts, inspection of moving components, measurement of vibrations of critical machines, inspection of safety gadgets, etc. During routine inspection, if anything abnormal is observed, the same is immediately attended. In case the defect observed cannot be attended immediately, it is recorded and rectification is taken up during preventive maintenance or planned maintenance schedules. Some of routine check charts are enclosed for reference purpose.

2.2. Preventive maintenance

Under this system, the equipment has been grouped together based on their functions like elevators, pumps, compressors, etc. In order to prevent breakdowns, a schedule maintenance is carried out with the explicit additional objective of detecting weak points and ensuring perfect functioning by replacing wornout parts. Some of the parts which could have given more useful life are also inspected and replaced in order to get the high degree of reliability of the machine for the purpose of production. Thus, after every service, the machine is expected to perform as new. Of course, during the process a judicious judgement, based on the experience of previous behaviour of machine, is taken, in order to have a control over the preventive maintenance cost.

The life span of major equipments in the plant, like elevator, chains, sprockets, buckets, belt conveyors, troughing rollers, granulator rubber panels, dryer pinions, trunnions and bearings of vital equipments are established, based on the almost 20 years operational experience of the plant. Though, the routine maintenance of all these equipments is carried out, the intensity of inspection is increased for the major components which are nearing completion of their life span, or already completed their expected life span. Under the close observation, efforts are made to derive the maximum useful life of the machine components, without, resulting in serious breakdowns, as well as without affecting the quality of the product.

During preventive maintenance at the KANDLA UNIT, the philosophy of preventive maintenance, is to replace the full unit assemblies of a machine. For example, if a bearing of a fan is found damaged, only the bearing is not replaced at site. The whole rotor assembly is taken from central workshop/warehouse and is replaced at site. The rotor assembly removed from the site is taken to central workshop, stripped fully, all components are checked and the assembly is prepared after replacing /repairing the damaged components. This assembly is kept for next replacement. This gives greater degree of reliability and better performance. We have found, this unit replacement system is giving beneficial results at our Kandla Plant site. Thus the same system is continued to be followed at this unit.

2.3. Predictive maintenance/planned maintenance

The objective of predictive maintenance is to enable the Maintenance Manager to predict an impending failure, so that casual break-downs can be avoided especially where safety hazards and penalty cost of failure is high. In order to implement the predictive maintenance programme, a list of critical machines is prepared and a data base for assessing their condition is maintained on day to day basis. The data base includes, vibration measurements, thickness measurements, bearing condition monitoring, routine check ups, etc. This data base is used for assessing plant and equipment condition and to provide forewarning of the deterioration so that the maintenance action can be planned and scheduled before the failure takes place. Therefore, the ability to forecast equipment behaviour and performance is a necessary requirement of predictive maintenance. This helps in determining the realistic preventive maintenance schedule. The critical equipments whose behaviour is under regular observation and monitored at IFFCO-Kandla are mainly rotary dryers, granulator, product coolers, bucket elevators, conveyor belts used for critical services, fans, pumps, scrapper loaders, etc.

The maintenance of the above equipments is planned based on the prediction of the life span of the major components such as chains of elevators and their head shaft assemblies, conveyor belts, trunnions, gears, gear boxes, etc. of rotary equipments like dryers, coolers and granulators. The above components are replaced or repaired depending on their condition.

The predictive maintenance system helps in better planning of preventive maintenance, planning of input resources like spares, materials, manpower and reduces breakdown rates, thus, ensures better availability of plant stream-days.

2.3.1. Case studies

2.3.1.1. Dryer "B" major maintenance

Technical specifications

Shell diameter:	12 ft.
Shell length:	80 ft.
Shell weight:	220 MT
Live load:	41 MT
Shell slope:	1 in 30
Shell speed:	4.5 rpm
Shell material:	IS:2002, 2062 & 226
Ring gear:	15" width x 176 teeth
Pinion:	16" width x 19" diameter
Shell Mfd by	Binny Ltd, Madras (ECC, Bombay)
Erected and Commissioned:	Hindustan Dorr-Oliver Ltd with imported tures, trunnions, thrust roller, ring gear and pinion by M/s.McDermott USA and gearbox by M/s. Foote Jones, USA.

Repair of damaged shell portion of Rotary Dryer

Dryer B is in operation since 1974 and has given satisfactory performance for the last twenty years with normal running maintenance. Of late, during the last quarter of the year 1993, several cracks in longitudinal and circumferencial directions in 32 mm & 16 mm thick plates were observed at tyre pad portions, near the ring gear and the hammer plates.

These cracks were of complex form and were propogating in a tree branch form. Down time of the dryer means total stoppage of production. Therefore, the course of action for repair was decided as follows:

a. Carry out immediate temporary repairs and commission the dryer to get some reasonable period for making necessary preparations for major repair.

b. Make necessary preparations.

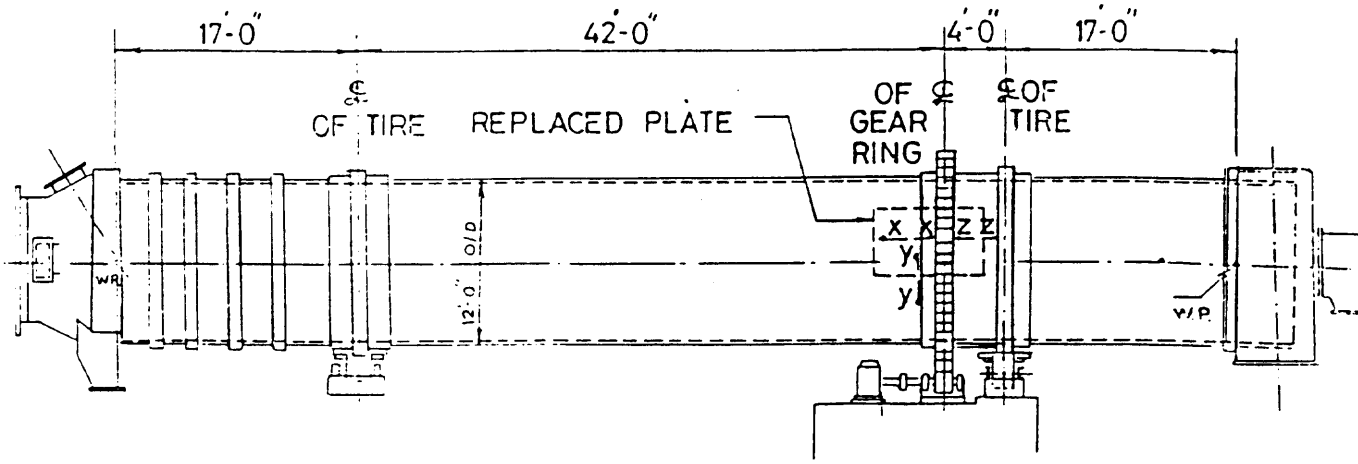
c. Have shutdown and carry out major repairs.

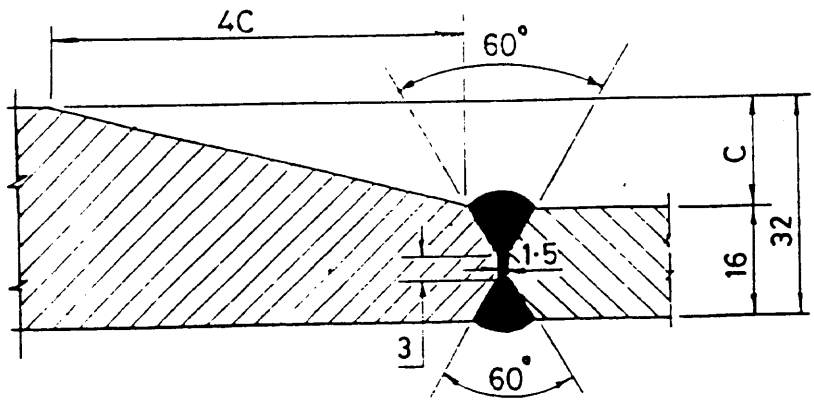
d. Trial run and re-commissioning.

During the month of November/December 1993, the shut down of the dryer was taken and the cracked portions of the 32 mm thick shell plate below the ring gear were cut and replaced by new plate patches rolled to suit the profile of the existing shell. Double 'V' edge preparation of plates were made and the welding was performed. The welding electrodes used are given in the sketch. All the balance weld joints of dryer shell were inspected by NDT methods viz. DP test, MP test, and ultrasonic flaw detector. The shell plate thickness covering major part of the shell was checked to ascertain the extent of thickness reduction of shell plate on account of corrosion losses.

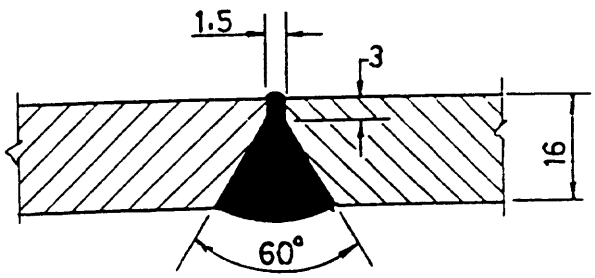
The damaged 16 mm thick shell plate portions at knocker hammers located at feed end of dryer were also cut and replaced with new plates by single V edge preparations and welding. Tyre pad shiming was also done to correct air gap to maximum possible level with suitable shims. The above repair work could be completed with round the clock work within 30 days. The bar chart showing the time taken in different activities is enclosed. On completion of repair work dryer was taken in line after satisfactory trial run.

ROTARY DRYER

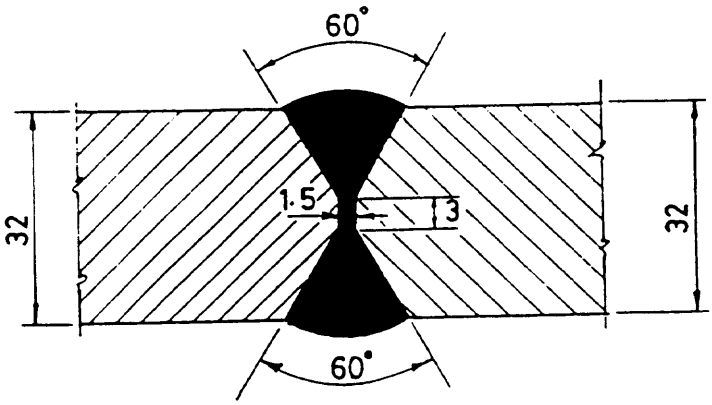




DETAIL 'xx'



DETAIL 'yy'



DETAIL 'zz'

WELDING ELECTRODES USED -

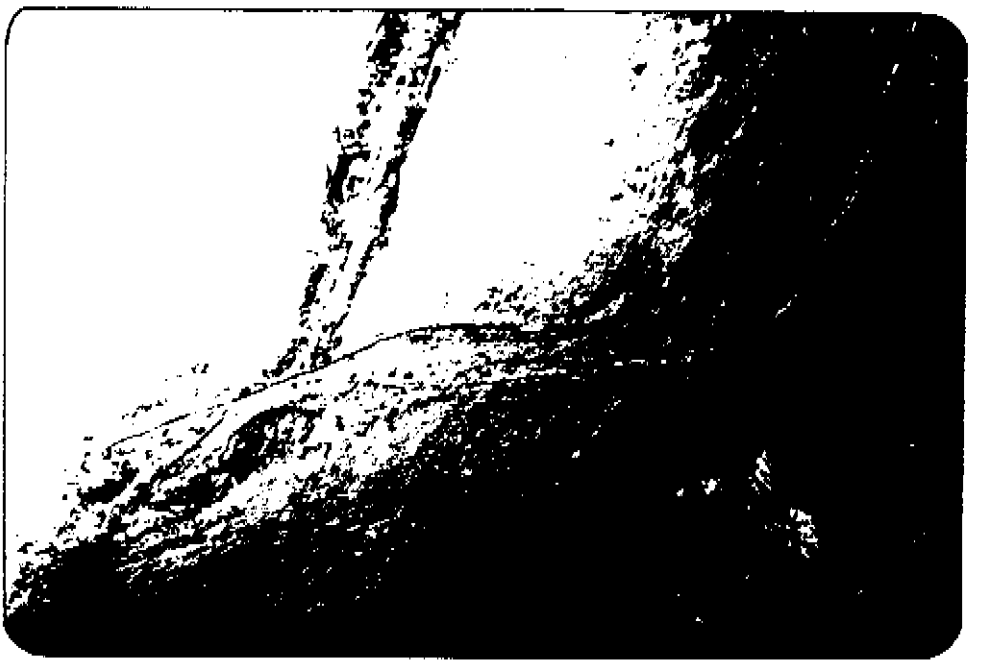
EDGE PREPARATION BY GOUGING / GRINDING

ROOT RUN - WELDING ELECTRODE
660 NH (L&T MAKE)

FILEER RUNS - WELDING ELECRODE
CPEP-021 (L&T MAKE)

PREHEATING TEMP - 150-160°C

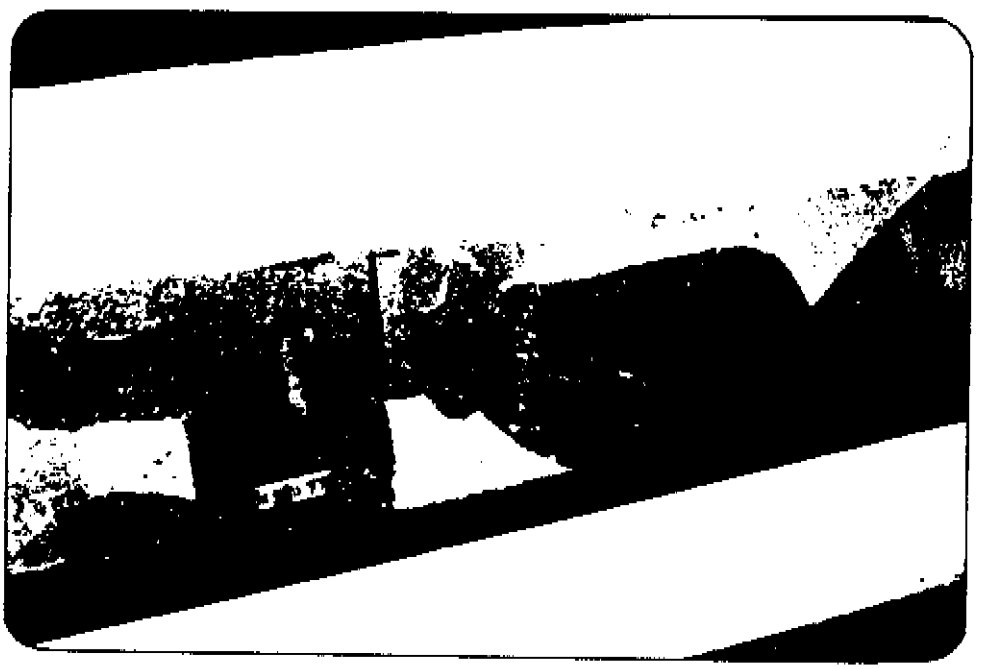
ALL DIMENSIONS ARE IN m.m.
UNLESS OTHERWISE STATED.



Photograph showing a typical crack in 16 mm thick shell plate near girth gear (viewed from outside)

Photograph showing a typical crack in 32 mm thick shell plate near girth gear (viewed from outside)

Photograph showing a typical crack in 32 mm thick shell plate
(viewed from inside)



Photograph showing a typical crack in 16 mm thick shell plate
(viewed from inside)

2.3.1.2. Repair of fractured tyre of rotary dryer

During the course of periodical inspection on 6.4.1994, it was found that discharge end tyre had fractured to its entire cross section (5" thick). The specifications of the tyre are:

Face width:	15" (381 mm)
Inside dia:	147 1/2" (3746 mm)
Outside dia:	157 1/2" (4000 mm)
Finish:	Machined to 250 micro inch.
Material of Construction:	Forged steel as per ASTM-A-26

This was first such failure of tyre in 20 years of service. The dryer was shut down, emptied, washed and made ready for the repair of fractured portion of the tyre.

The carbon content of the tyre material is 0.60 - 0.80%, which comes under the medium carbon steel and the repair of such high percentage carbon steel requires special care. Since the tyre had worked continuously for 20 years in a cyclic loading condition, the work hardening of the same was also expected. Hence, it was decided to take the opinion of maintenance welding expert of M/s. Larsen and Toubro Ltd, Bombay for better selection of electrode.

Repair procedure was:

Cracked area was cleaned and V-groove for edge preparation by gouging was made. While carrying out the gouging operation for V-groove preparations, piped blow holes and perforation as inherent defect in the tyre cross section were observed. Hence, ultrasonic scanning of the whole tyre surface was carried out to check for any such defects in other areas. No further appreciable defects were found.

In order to reinforce the weld metal with parent metal, steel rods of 1" dia were placed at right angle to fractured cross section. The arrangement of V-groove and rod is shown in enclosed sketch.

Local pre-heating of the joint before the welding was carried out by oxy-acetylene torch up to 300 degree centigrade. The welding electrode chosen for the work was of M/s. EWAC Alloys Ltd made the Eutec Electrode Xuper 660 NH and XHD 2222.

The root run and first two layers of weld on entire surface of the V-groove were overlayed with Xuper 660 NH electrode which have the characteristics of purging the hidden defects. Subsequent layers of weld were filled with electrode XHD 2222 producing tough welds. All the layers of weld were made by stringer bead technique. Care was exercised to maintain the interpass temperature between 250 - 350 degree centigrade. Also peening of the welds were done in the course of laying the subsequent layers.

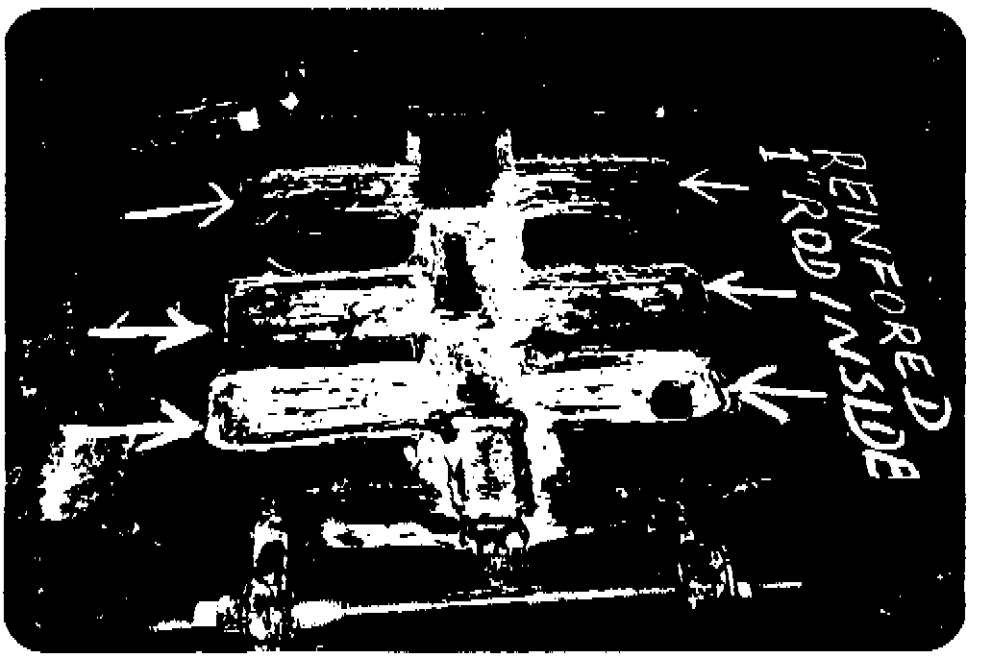
The other side of V-groove was made by cutting the 32 mm thick shell plate under the joint, to facilitate the approach for preparing V-groove and its welding.

The inside tyre surface was ground finished by hand grinders after welding was completed. The shell plate which was removed for making approach for welding of tyre was again welded in position. The outer surface of the tyre was also made smooth by using hand grinders. The curvature of outer and inner surfaces were made to match the original curvature of tyre.

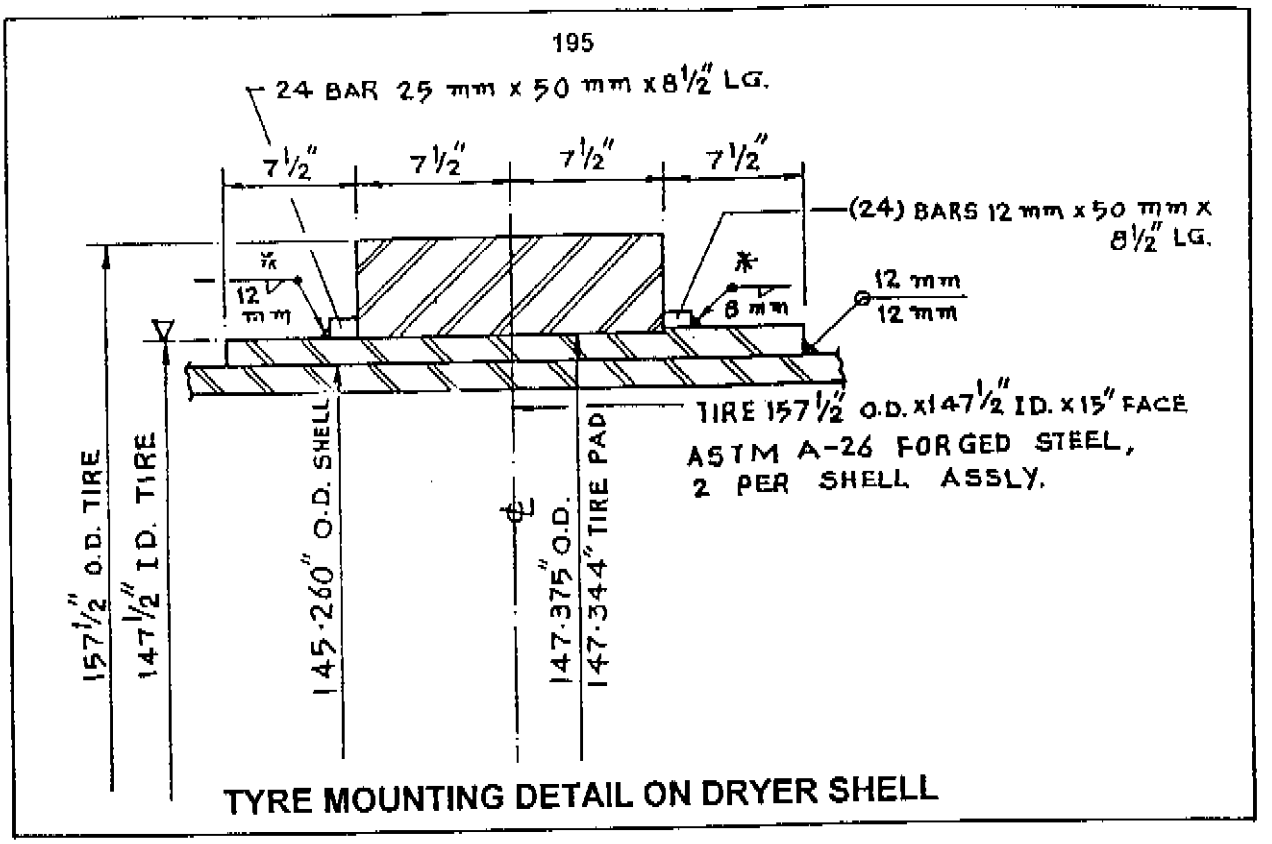
Post-weld heat treatment was carried out for removing residual stresses due to welding.

The dryer was put back to operation on 21.4.94 and since then it is running satisfactorily.

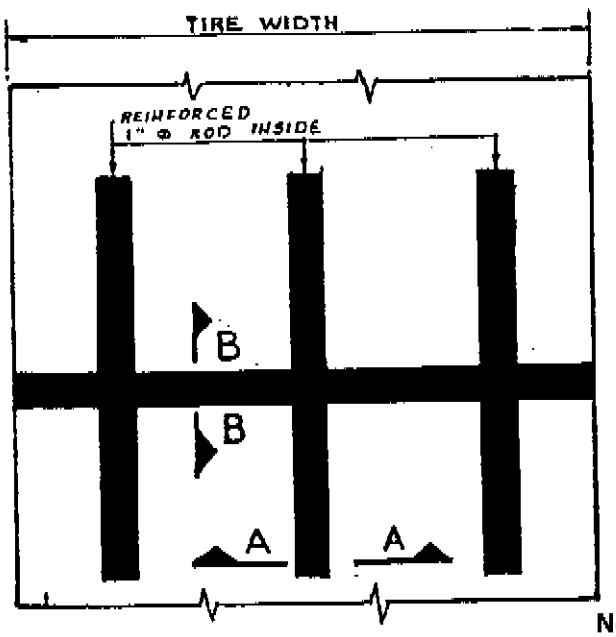
Photograph showing blow holes in the Tyre at the cracked portion

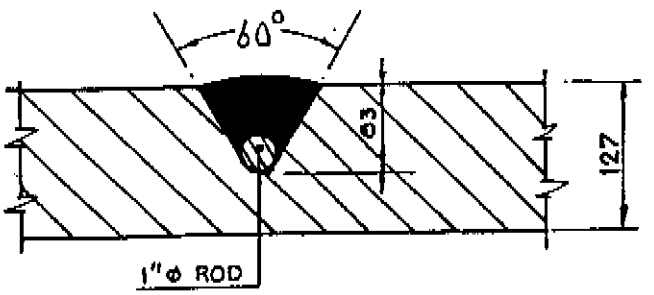


Photograph showing the partially welded joint of cracked Tyre



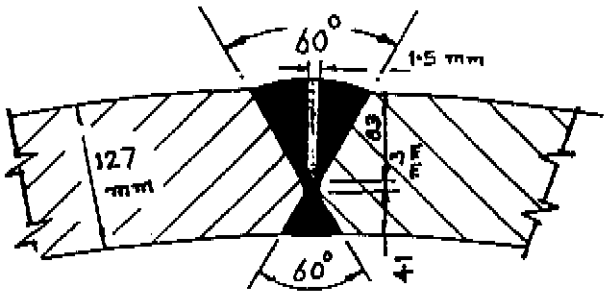
TYRE MOUNTING DETAIL ON DRYER SHELL





SECTION-AA'

Note: All dimensions are in mm unless otherwise stated.



SECTION-BB'

EDGE PREPARATION DETAIL AT REPAIR JOINT OF TYRE

2.4. Breakdown maintenance

In spite of a good amount of routine, preventive and planned maintenance, breakdowns do occur in the plant. During the breakdown of the plant, the workforce from the central pool of workshop is mobilised to carry out the repair work to the desired level of performance under the guidance of the Plant Maintenance In-charge. The spares and other resources are also mobilised on priority basis to reduce the loss time.

2.5. Capital replacement/modifications

The life of various equipments are being monitored and history card of all the equipments are maintained. The available useful life of the equipment versus their cost of repair are analysed and when the repair is uneconomical, the capital replacement of the equipment is carried out. Based on the experience in the plant, sometimes we find that certain equipments are demanding more maintenance i.e. their reliability is less. In such cases, alternative means for performing that activity are studied and if possible modifications in the system or replacement with a more reliable one item is taken up. Some of the modifications carried out in the plant are given below:

1. There were considerable plant downtime on account of failure of bucket elevator chains, bearings of head shaft assemblies and hold back assemblies. The elevator chains were replaced with heavy duty chains. Bearing blocks of head shaft assemblies were provided with labrynth seals in order to prevent entry of dust which was the major reason for the failure of head shaft bearing assemblies. The hold back assembly provided in the gear boxes were of lower capacity and were failing very frequently. Heavy duty hold backs were selected and installed. The above modifications were successfully carried out, which has helped in improving the plant performance and reducing the downtime.

2. There were frequent problems on account of choking of slurry lines due to solidification of the slurry. The slurry lines were earlier jacketed leaving approximately 4" to 6" length of the inner pipe near flanges. This was causing cooling of slurry at the portions of the pipe lines. As a result of it frequent choking was taking place. In order to overcome this problem, steam jacket pipings were extended upto flange. This modification has reduced the choking of slurry pipe line.

3. The oversize pulverisers were the greatest bottleneck in the plant on account of the failure of bearings and high vibrations. The rigidity of the casing was increased by increasing the thickness of pulveriser casing from 16 mm to 25 mm. The bearing of heavy duty and higher size were selected and installed. This has improved the performance of the pulverizers.

4. A number of modifications have been carried out in the belt conveyors by increasing the diameter of drive pulleys, tail pulleys, installing higher size of bearings, modified take up assemblies etc. By incorporating the above modifications, greater reliability of belt conveyors could be achieved and plant downtime on account of this is reduced.

3. RECORD KEEPING AND INFORMATION SYSTEM

The history cards for each equipment is maintained and important datas like replacement of bearings and major components are computerised for the purpose of ascertaining the frequency of replacement and the cost of maintenance to be incurred for future maintenance.

4. SPARE PARTS INVENTORY

Inventory plays a major role for satisfactory maintenance of the plant. System of maintenance at our unit is to replace the complete sub-assembly as far as possible during preventive maintenance. The removed sub assembly is taken out from the plant and is thoroughly overhauled in our workshop and kept ready for future use. This reduces the time of maintenance at site and also the reliability of the equipment improves. A reasonable stocky of spares, bearings and other consumables are readily available for maintenance whenever needed.