Some Parameters For Overloading a Recovery Boiler

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The article deals with several parameters for overcoming the difficulties encountered in overloading a chemical recovery boiler. Various factors like regular unit inspection, equipment modifications, process improvements and the future trend of changes in design, have been discussed. With the higher proportion of hardwoods as the pulping raw material, overloading of the recovery boiler becomes inevitable and the traditional problems connected with overloading assume new dimensions which, naturally, draw attention of the operating personnel. A fresh approach in finding solutions to the problems becomes essential. Many hints have also been given to the recovery boiler manufacturers who, nevertheless, play an important role in developing better designs to suit the rapidly changing needs of the recovery process.

Introduction

The Tomlinson recovery unit at the West Coast Paper Mills has more than a decade of its history which is very peculiar and unique in nature. The variety of problems encountered in the mills have given new experience to the designers who became rich in first-hand information for developing better future designs of similar units. Details of the experience enumerated in this article have been found to be useful in improving the operation of several units elsewhere in the country. The article deals with overloading problems in the past as well as in the present and the future precautions to be taken for improving the unit availability at present rate of overloading.

Avoiding frequent stoppages

In order to meet the main objective of overloading the recovery boiler i.e. to cater to the cooking liquor needs for higher pulp production rates in pulp mill, it becomes very essential that the availability and reliability of the unit should be kept upto the mark. Efforts should be made to ensure that breakdowns of the main equipment or its auxiliaries, demanding unplanned shutdowns are minimised. Very frequent breakdowns cut down the unit availability drastically thereby defeating the very purpose behind overloading the unit.

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All the main and auxiliary equipments like fans, pumps, etc. are running in their maximum/overload capacities and hence demand a close check up. An effective preventive maintenance schedule is very essential to achieve this. The following points, if implemented, should definitely improve the unit availability.

i) Regular inspection rounds for external check up of all the auxiliaries like induced and focred draught fans, liquor spray pumps, soot blowers, smelt dissolver agitator etc. Defects observed, if any, should be noted down and attended to at the first possible opportunity. An early shut down should be planned for any serious defect and meanwhile the unit be kept on stream by some stop gap treatment if immediate shutdown is not possible.

ii) A systematic lubrication schedule for proper lubrication of all the lubrication points, depending upon its desired frequency. Critical points should be kept in mind and checked up during routine inspection rounds.

iii) A complete record of the history of each equipment should be maintained. Exact details of all the maintenance jobs should be entered in chronological order. This is very helpful in predicting the exact behaviour of an equipment and precautions to be taken can be easily framed.

iv) A thorough internal check up of all the sections of the unit be carried out for any distortion, corrosion/pitting or any other trouble. Corrective steps should be taken beforehand so that breakdowns are minimised later on. If a major modification/renovation is required, some stop gap arrangement can be made to keep the unit on stream, in case an immediate shutdown is not possible. Later on, the said job should be planned and executed at the earliest opportunity.

v) Frequency of intermediate and cold shutdowns of the boiler should be such that

   a) total liquor firing stoppage period is minimised in a year;

   b) fuel oil consumption is also moderate.

Too frequent intermediate shutdowns will mean an increase in oil consumption (for melting down the char bed and again stabilising the furnace) whereas too less frequent ones may lead to serious troubles like spout blockages, liquor spray gun unit getting damaged due to impact of hard stuff falling from above and extra hard deposits in superheater region which increase boiler cleaning time. personnel fatigue, overtime bills and depreciation of unit itself, in addition to higher fuel oil consumption. An optimum has to be found between the two cases. In our plant this optimum works out to be somewhere between 1700–1800m^3 of liquor fired between two consecutive intermediate shutdowns. Experience has shown that the boiler cleaning time and the personnel fatigue show an almost exponential rise above 2000m^3 liquor firing. Hence this factor is very important from the point of view of unit availability.

vi) Before taking the boiler off range for a cold shutdown, it has been found advantageous to carry out a thorough melting down of the hearth, as usual, with boiler cleaning continued externally. In addition to easing dislodging of the remaining stuff later on, this means a direct saving in hearth cleaning time by about four hours.

Process variables which are likely to improve the operating conditions

Combustion air temperature

Providing cooler denser air to different combustion zones in the furnace has the effect of lowering slightly the operating temperature in the particular combustion zone and hence the upward velocity of flue gases in the furnace. This means a reduction in carry over of particulate solids. But experience has shown that the furnace conditions become unstable whenever cold ambient air is fed to the primary combustion zone. Therefore, trials were carried out with feeding cold air only to seeondary zone of the furnace. The arrangement consisted of a separate ducting from outlet of the forced draught fan to the secondary windbox, bypassing the air heater. Marked advantages which resulted can be listed as—

a. Overall air carrying capacity of the ducting increased which facilitated going for higher production rates with the same forced draught fan;

b. Secodary zone wind box pressure has increased from 80–90mm WG to 170–180mm WG thereby maintaining higher air velocity at secondary parts and hence a thorough mixing in this combustion zone. Hence due to the increase in rate of combustion reaction, the combustion is almost completed in lower zones of the boiler. Heat transfer rates in the radiation zone also go up and the resulting lower flue gas temperatures at the inlet of screen tubes and superheater regions have a favourable effect on quality of deposits in these regions. Flue gas temperatures below the ash fusion transition temperature (1400–1600°F) result in very soft deposits which are either blown off during soot blowing or can be knocked down easily during intermediate shutdowns of the boiler.

Alternatively, with the lower wind box pressures in the secondary zone (as with the earlier arrangement), the combustion reaction being slower and the mixing of reactants being poor inspite of high overloading, the inlet flue gas temperature of the superheater zone lies in the ash fusion transition range, yielding extra hard and difficult to clean deposits in this region.

This is a direct saving in terms of boiler cleaning hours (and hence availability), personnel fatigue, overtime bill and above all the life of the boiler itself.

c. Better mixing/cumbustion in the furnace means completion of the exothermic combustion reaction there itself and hence a higher steam generation rate because of the extra radiation heat transmission in the furnace. Thermal efficiency of the boiler has increased from 37% to about 49%. Superheater outlet steam temperature also stays within the tolerable range due to lower superheater inlet flue gas temperature.

d. As a result of better mixing in the secondary zone, the odorous emissions from the boiler, viz. hydrogen sulphide and the mercaptans are reduced to negligible, tolerable limits. Hence it is advantageous even from the pollution control point of view.

Design of superheater

It is needless to mention that the superheater should be properly designed in a recovery boiler. A badly designed superheater system is likely to bring down the boiler availability to a great extent, especially under overload conditions.

The fusion temperature of condensing fumes and salt cake carry-over from the furnace varies from 1350°F to 1500°F (732°C to 871°C) depending on the eutectic mixture of the chemical ash. The superheater must operate in an fusion temperature transition zone where deposits are sure of form. The design arrangement of superheater surface must consider operation over a wide range of flue gas temperature and ash conditions.

The superheater at the West Coast paper Mills' recovery boiler originally consisted of 19 tube elements, arranged on 5-inches side spacing of tubes, with 6 loops in each element. The resulting high superheated steam temperature (>450°C) even on normal load operation forced us to remove 22% of the original superheater surface initially and another 4% in the second modification. This brought down the temperature to 400–420°C. But, with the side spacing of tubes still remaining 5 inches, it resulted in heavy fouling of the flue gas passage in this region when the boiler was run under overload conditions. The current thinking at the mills is to rearrange the superheater elements on a 10 inches side spacing of tubes so that fouling is less and unit availability is more. The proposal is to re-arrange the existing superheater surface in such a way that side spacing of tubes is increased, with a parallel flow arrangement for steam and flue gases instead of existing mixed flow. This type of arrangement is also favoured by Babcock & Wilcox ('Steam–Its Generation and Use'–p.p.20–29) as–

"The superheater is arranged for parallel flow of gas and steam. Saturated steam enters the front tubes of the superheater in contact with the hot gas and flows through successive loops so that the final tube with the hottest steam is in contact with cooler gas. There is a dual advantage with this arrangement. First, cooling of the gas is most rapid at the front of the superheater where the need for cooling the ash is the greatest. Second, the parallel flow arrangement results in lower average tube-metal temperature. This is particularly desirable in recovery units designed for steam temperatures about 700°F'"

Higher capacity draught fans

With the recovery boiler operating under considerably high overload conditions, the capacity of the induced draught fan (s) becomes a bottleneck in maintaining a proper draught in the furnace. Under such conditions, it is desirable to go in for higher capacity fan (s). The factors worth considering while calculating the new capacity are–

i) **Furnace draught :** As discussed above, it is very important to maintain a balanced draught in the furnace and other sections of the boiler at all times. So, the increase in flow rate of flue gases at the present firing rate must be considered.

ii) **Recirculation of flue gases:** In some cases, it may be desirable to recirculate a part of the outlet flue gases to a section before the superheater, the purpose being to bring down the inlet flue gas temperature at this zone to well below the ash fusion transition temperature so that the deposits are softer in this zone. In such instances the induced draught fan capacity should be decided after taking into consideration the required rate of recirculation. (Not in practice at W C P M).

iii) An added advantage of the higher capacity fan (s) is the improved working conditions for the personnel engaged in cleaning operation (during intermediate boiler shutdowns) by minimising backfire and thereby increasing their working efficiency.

Quality of Black Liquor

When different types of hardwood cooking is carried out, the characteristics of black liquor change to an enormous extent. Evaporation of the liquor both at the multiple effects evaporators stage and at the cyclone evaporator stage becomes a difficult task. At times we have to add a good amount of white liquor in these stages. Cooking conditions will have to be properly readjusted (percentage of A.A. charged, time of impregnation, cooking temperature, etc). Many times it may be advantageous to increase the active alkali charge at the cooking stages rather than adding the same at the evaporation stages. A mill will have to decide whether hardwood black liquor is to be processed separately or with bamboo black liquor.

Higher concentration and Temperature

Another effective way of increasing the effective capacity of a boiler is by increasing the percentage of total solids, i.e. the concentration of the firing liqour. This reduction in the inherent moisture content of the fuel means a corresponding reduction in the amount of fuel gases generated and hence the gas velocities in furnace and boiler sections, particulates carry over and the load on the induced draught fans go down. A glance at the table below shows that if the firing liquor concentration is increased from 58% to 64% T.S., the velocity of flue gases in furnace zone under this particular firing rate goes down from 567 m/min. to 540 m/min., viz. a 5-6% increase in concentration yielding a drop in the gas velocity in the same proportion (5%). This is quite appreciable from the point of view of particulates carry over and hence the recovery efficiency.

The governing factor in fixing the new optimum firing liquor concentration is its viscosity and hence the difficulty in pumping. The black liquor in the range 60-65% T.S. is a very steep viscosity gradient in relation to concentration. Above 65% T.S. the viscosity becomes so high that it is almost impracticable to pump this liquor. Hence an optimum is struck at 64-65% T.S. Even at this viscosity, there are bound to be serious pumping troubles if the firing liquor temperature is maintained at the conventional 95-100°C. To counter this trouble the firing liquor temperature has been increased to 119-120°C. Experience has shown this combination of about 64% T.S. and 119-120°C firing temperature gives a liquor spray which is coarse enough to reduce odorous emissions and particulates carry over and free from pump troubles. Higher thermal efficiency due to more heat available for steam generation is another aduantage.

TABLE

% T.S.	Wt. of dry gas Kg/min	Wt. of water vapour Kg/min	Vol. of dry gas m^3/min	Vol. of water vapour Kg/min	Total volume m^3/min	Vertical velocity m/min
58	782.0	155.0	270.0	12180	3920	567
59	,,	151.3	,,	1180	3882	560
60	,,	147.3	,,	1149	3851	556
61	,,	143.5	,,	1119	3821	551
62	,,	140.0	,,	1091	3793	547
63	,,	136.8	,,	1068	3770	544
64	,,	133.3	,,	1040	3742	540
65	,,	130.0	,,	1013	3715	537
66	,,	127.0	,,	989	3691	531
67	,,	124.0	,,	966	3668	528
70	,,	115.5	,,	900	3602	520

Data :

Rate of B.L. firing = 192 tonnes of B.L. solids/day
= 133.3 kgs of B.L. solids/minute

Ultimate analysis

Elements	% wt. basis
C	38.6
H_2	3.6
S	3.6
Ash	44.7
$O_2 + N_2$	9.5
	100.0

Elemental analysis

Elements	% wt basis
C	42.6
H_2	3.6
S	3.6
Na	18.3
Inerts+mineral oxides	0.2
O_2	31.7
	100.0

Air requirements @ 10% excess = 5.46 kg/kg B.L. solids.

Flue gases generated :

Dry gases = 5.86 kg/kg B.L. solids.
Water vapour = 1.16 kg/kg B.L. solids.

Gas velocity across the recovery furnace calculated on the projected cross-sectional area (= m^2 at the West Coast Paper Mills furnace). The range of gas velocity prescribed by B & W is 500–800 ft/sec. whereas, in practice it is more than double that amount.

Double smelt spouts

At higher overload in the boiler, the chances of the smelt spout getting blocked are very high due to huge pieces of hard deposits in upper portions of the furnace/boiler getting loosened and falling over the spout. The resulting smelt pool in the furnace may be sufficient to force an emergency outage of the unit and/or suspension of liquor firing till the spouts get cleared. The introduction of two spouts instead of one centrally located earlier, can avoid this problem to a large extent. In the event of one of the spouts getting covered/blocked, the liquor firing need not be stppped immediately. With the other spout in service, the smelt accumulation never reaches an alarming position and efforts can meanwhile be made to open the blocked spout. The possibility of both the spouts getting blocked simultaneously is quite remote.

Primary ports in front side of the recovery furnace

In addition to the provision of double spouts, the problem of spout blockage can further be avoided by introducing a couple of primary air ports on either side of the spout(s). This will keep the char bed in the vicinity of spout(s) area active and prevent it from freezing. Even in the event of some hard stuff falling over the spout, the active char bed In the surrounding region will melt it off and the spout will get cleared quickly.

Extra doors for cleaning

With the boiler running under

high overload conditions, the deposits in boiler will be much more compared to the unit running at rated capacity. The provision of extra access doors in relevant portions of the boiler will greatly facilitate the cleaning operation during intermediate/cold shutdowns, the idea being to have a greater stuff accessibility from outside; governing factors for number of doors being the cleaning time, and boxing up/deboxing periods.

Diversion of brine solution

In case of units with venturi scrubber type of secondary recovery systems, the brine solution from the cyclone separator is usually bled off into the cyclone evaporater (as the secondary recovery contribution to the recovery system). Alternatively, this brine solution can be dosed into the black liquor system of the smelter/roaster units whenever these are employed to supplement the recovery unit capacity. This will further lower the moisture content in the firing liquor as the moisture in the brine solution does not enter the system now. Instead the desired make up can be maintained by increasing the dry salt cake make up rate accordingly.

A very important advantage is the reduction in the chloride ion concentration in the cycle as the brine solution is very rich in sodium chloride content and is a source of high chloride ion concentration in the cycle. The amount of chloride recycled from smelter/roaster units is very small comparatively.

Smelt leakage from furnace hearth

Leakage of smelt from furnace hearth is a trouble which can cripple the smooth running of a boiler and drastically cut down its availability. Every time there is a leakage of smelt from the hearth the unit has to be taken off range till the smelt in the affected portion is freezed. This; in addition to the production loss in the period required to take the boiler back on range, is very detrimental to its very life due to the freqnent thermal shocks it receives if the trouble is allowed to recur uncared for. There may be undesirable distortion in high temperature zones ef the boiler. Precautionary measures warranting special attention are–

i) **Wall construction** : Construction of tube walls on the furnace hearth and all the four sides should be effective enough to hold molten inorganic chemicals without permitting them to pass through. Any gaps created by loss of rectangular studs or tube distortion should immediately be rectified. The latest in wall construction is the membrane wall construction with rectangular studs replaced by a long rectangular strip/bar welded to the tube on either side of it.

ii) **Refractory material** : The particular refractory material used in the furnace section should withstand the corrosive action of molten chemicals and the high temperatures it is subjected to. This is very important since the governing mode of heat transfer in the furnace section should essentially be by radiation. The only conduction heat transfer should be through the pin studs embedded in the refractory. In the event of furnace refractory erosion, the hearth tubes will come in direct contact with the hign temperature smelt and there is every possibility of corrosion and distortion of the tubes. Once membrane wall tube arrangement is disturbed by displacement or distortion of tubes, smelt will start passing through it. The refractory material should therefore be properly selected and the manufacturers' instructions should be followed closely while applying and curing it. Only then the unit should be taken on range. Ageing is another important factor govering the service a refractory will give. Even a good refractory cement, if stored for a time before use, is bound to lose its effectiveness to some extent. Hence the use of a long-stored refractory cement should be avoided.

iii) **Inspection :** A thorough inspection of the furnace hearth condition is very important at the time of annual shutdown. The refractory and tube walls condition should be thoroughly checked up. In case of a refractory erosion it should be properly patched up or, if conditions demand, renewed completely. A routine check up should be carried out during each cold shutdown also. In the event of any tube distortion/loss of fins or studs, it should be rectified. If the distortion is too much in any section, the affected tubes should be replaced with new ones. The same is applicable in case of any tube corrosion/pitting.

A complete renovation of the high temperature zone(namely, furnace zone) tubes may be desired after about 10-12 years of service under overload conditions. This can occur due to heavy distortion of furnace hearth and side wall tubes near primary air ports level and below due to continuous overloading. So a long shut down can be planned for this type of renovation whenever desired.

iv) **Cooling arrangement** : Provision should be made for suitable compressed air lance pipes to freeze the minor smelt leakages from hearth so that the instances of taking the boiler off range are minimised. In case of severe leakages, an early cold shut down should be taken to carry out the internal inspection and the necessary rectification.

v) **Excessive air lancing** : Prolonged use of the compressed air lance at primary air ports to improve combustion in zones of poor combustion should be avoided. This can cause weakening of a tube due to constant application of flame directed at one place by the air lance. In the long run this may lead to a tube failure when the loss of metal makes the tube very thin.

vi) **Bottom casing plates** : The layer of refractory below hearth tubes and another layer of insulating material below it together serve as a sort of double protection against leakage of smelt. To make it completely foolproof, both these plates can be completely welded, if necessary, all around so that minor losses of fins/studs do not lead to smelt leakage.

vii) **Refractory damage during intermediate shutdown** : Large pieces of boiler deposits when knocked down during intermediate/cold shutdowns will damage the hearth refractory and studs. This can be avoided to some extent by introducing rods through inspection doors during shutdowns on operating floor to creat a sort of net which will dampen the velocity of falling stuff. Moreover, this arrangement keeps the spout clear by avoiding any stuff from falling in front of it.

Reducing dead load in the recovery cycle

The white liquor used for cooking in the digesters also contains chemicals like sodium carbonate, sodium sulphate, sodium thiosulphate, sodium chloride and some calcium compounds in addition to the cooking chemicals sodium hydroxide and sodium sulphide. These chemicals do not take part in the cooking reaction at all and constitute a sort of dead load in the chemicals recovery cycle. These cannot be got rid of completely. However efforts can be made to reduce, this dead load in the system. Following steps do contrihute in achieving this–

i Increasing % causticity in white liquor,

ii Increasing % sulphidity in white liquor,

iii Improving the clarity of white liquor, and

iv Reducing the chloride ions concentration in the system.

i. **Increasing the % causticity** : An increase in the causticity of white liquor means a reduction in the system's dead load due to sodium carbonate. However, this will lead to an abnormally high lime consumption (at very high % causticities) because of reversible nature of the causticising reaction. This also means higher chemical losses in the causticising section.

On the other hand, this reduction in sodium carbonate dead load will reduce the chemical losses in brown stock washers and recovery furnace, thereby increasing the effective capacity of all equipments in the recovery cycle. Generally, the % causticity in kraft process in the range 83-84% is favoured, balancing the advantages and disadvantages. In soda mills, though, a causticity of 89-92% is considered very favourable.

ii) **Increasing the % sulphidity :** Increase in sulphadity of the cooking liquor lowers the cooking time required for the same yield and pulp quality as measured by the lignin removal. A low sulphidity of of 5.26% gives a yield of 49% at 160°C in 7 hours while 10 hours are required to give the same yield and pulp quality at zero sulphidity. At higher sulphidities the effect is even more marked. At 31% sulphidity and 160°C temperature, the same yield is obtained in about 5¾ hours.

Quality of the pulp and strength properties are better because of the selective action of sodium sulphide on lignin which means less degradation of cellulose.

Extensive investigations on role of sulphidity in kraft pulping indicate a critical level of 15-20% sulphidity and no major improvement in the cooking rate above 25%.

iii) **Improving white liquor calrity:** Overflow liquor from the white liquor clarifier, which is the white liquor being pumped to Pulp mill, contains fine suspended solid particles of $CaCO_3$ to the extent of 50-100 ppm depending upon the lime quality and the white liquor clarifier operating conditions. This $CaCO_3$ content in the cooking liquor deteriorates the quality of pulp. Moreover, it aggravates the multiple effect evaporators tube scaling. Polishing of white liquor by means of a system of centricleaners (tube separators) is desired to avoid these troubles. By employing a suitable set of centricleaners, the turbidity in white liquor can be reduced to as low as 10-15 ppm.

iv) **Reducing the chloride ions concentration :** The source of chloride ions which are a cause of chloride corrosion in the system in addition to being a dead load, is the make up chemicals like salt cake, fresh caustic, soda ash etc. But there is little outlet for these ions in the system with the result that these start building up fast in the system and start creating nuisance.

An effective way of getting rid of chloride ions from the recovery cycle is by purging out weak white liquor to the bleach plant at the cost of Na_2CO_3 and Na_2S loss carried along with this weak white liquor. These chemicals, although considered to have some effect in the bleaching process, cannot be called to have a satisfactory utilisation. This loss of chemicals is made up by adding an equivalent amount of fresh caustic to the cooking cycle.

Diversion of brine solution from venturi scrubber or other secondary recovery system to supplementary smelter/roaster units has been found the most effective, although at a considerable loss of chemicals due to poor recovery efficiency there.

Saturated steam for soot blowing

Superheated steam, when used for soot blowing operation, knocks down fresh, loose deposits due to high pressure of the lance. But in the case of the unit running under heavy overload conditions, the probability of hard fused deposits being more, superheated steam is not found to be so effective. Use of saturated steam or steam with very low degree of superheat is advisable for carrying out the soot blowing. This. in addition to dislodging the loose deposits, helps in cracking the fused mass due to thermal shock. The cracked deposits loose their hold in the furnace and fall. Precautions should be taken to avoid any condensate entering the boiler along with the steam; otherwise the tubes may also get a thermal shock.

Storage of heavy black liquor

High density (semi-concentrated) black liquor from the multiple effect evaporators can be conveniently stored in bigger capacity, properly lagged tanks whenever the recovery furnace is out of order. This does not upset the production programme of pulp mill during a recovery furnace shutdown. Moreover, this makes the operation of multiple effect evaporators units and the recovery furnace independent of each other. Separate shut downs for cleaning/maintenance can be planned for both the units and the down time can be minimised by utilising maximum of skilled personnel for this job. This increases the availability of both units.

When the recovery furnace comes in full swing after a shutdown, this high density liquor can be gradually consumed by adjusting the liquor firing rate. In case the storage of high density liquor is to be for longer periods, steam coils should be provided at the bottom of each tank to avoid pumping troubles due to thickening of liquor because of long storage and cooling.

Spare fans and rotors

Inorganic chemicals carried over along with flue gases get deposited on the induced draught fans impellers causing imbalance and hence severe vibrations. Washing the fan with hot water will dissolve the stuff and reduce the vibrations. But in the long run fine particles start depositing on impeller. These deposits are not washable and hence the fan starts running with continuous vibrations. In such conditions, the fan has to be taken out of service and the deposits scrapped. Another cause of fan vibrations may be the imbalance created by erosion of the impeller wear plates. Replacement of the damaged wear plates and balancing the impeller afterwards will solve the problem. But this requires taking the fan out of service for a few hours atleast. Moreover, in case the fan is allowed to run in imbalanced condition, failure of fan either due to damage of bearing, impeller, shaft, coupling or motor may occur. This will also result in long shutdowns of the recovery furnace and hence loss of production. Such breakdowns may occur at least 4-5 times in a year. The heavy loss of production can be avoided by installing a spare induced draught fan adjacent to the present one.

In case the plant layout does not permit the installation of a spare ID fan due to congestion, spare rotor fitted on shaft, bearings and plumber blocks, couplings, electric motors (if possible) and/or its aecessories, should be maintained at all times. This extra investment will go a long way in minimising production losses by putting the unit back into service after quick replacement.

The forced draught fan generally runs trouble-free in the first 10–11 years of its service because it handles fresh air from atmosphere. But, later on mechanical troubles may start coming quite frequently and it is advisable to keep spare rotor fitted on shaft, bearings, couplings, plumber blocks, motor, starter, etc. always in stock so that production losses are minimised. Again, if the spare permits, it is advisable to install a standby forced draught fan.

As far as possible, the inlet ducting of the forced draught fan should be positioned in such a way as to admit only clean air, free from salt cake and other chemical fumes. Inlet air contaminated with these particles enter the fan and are likely to damage the impeller in the long run.

Whenever venturi scrubber is used for secondary recovery of chemicals, suction chambers of ID_1 and ID_2 fans should be connected with suitable ducting and damper in it. Thereby, the furnace can be run on ID_2 fan, at a lower capacity though, and the maintenance work on ID_1 fan can be continued simultaneously. This will avoid production loss to a large extent.

Duplicate spray gunn nit

In one plant a duplicate spray gun unit has been installed. The previous unit was at a height of 16ft. from the spout whereas now it has been reduced to 13ft. This lower spray gun mechanism is the one in use with the upper mechanism serving as a standby. This lowering of liquor spray point has shifted the whole spray range on rear and side walls to a lower region with the result the honeycomb type of ledge formation which used to occur previously, has almost disappeared and the furnace operation has become very much free from rear ports trouble. A reduction in particulates carryover inspite of high overloading is another advantage.

Nozzle and gun coatings

An increase in liquor concentration at our plant had started giving thick nozzle and gun coatings because of higher liquor viscosity and hence lower liquor velocities. Spray gun punctures had become very frequent. This problem was solved by reducing the spray gun pipe from sizes 1½"Ø to 1"Ø. An immediate reduction in gun and nozzle coatings and hence spray gun punctures was observed because of higher liquor velocities in the spray gun pipe.

Reducing the superheater inlet flue gas temperature

As discussed earlier, the superheater inlet flue gas temperature usually exceeds the ash fusion temperature under overload conditions of the unit. This results in very hard deposits in the superheaters zone. These deposits can be replaced with much softer ones in case we can reduce the inlet flue gas temperature to the superheater zone. This can be accomplished in two ways.

The first one is by cold air feeding to the secondary zone which has already been discussed with all its advantages. In addition, a part of the outlet flue gases from cyclone evaporator can be recirculated to a region before superheater. By adjusting the recirculation ratio, we can adjust the inlet flue gas temperature to below the ash fusion temperature (1400–1600°F).

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