Refine pan design consideration for automation, an experience at Mehran Sugar Mills limited.*

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Abstract

As a part of plant cane crushing and processing capacity enhancement from 9,000 tcd to 11,000 tcd and simultaneously reducing steam demand, refine pan automation was considered at Mehran Sugar Mills Limited. There are 4 refine pans having 60 t strike capacity and 242 m² heating surface each. The design of the calandria is of floating type with central and lateral down take. Usually refine pan design, suitable for automation, is cylindrical shell having calandria with central down take, equipped with mechanical stirrer inside the down take. For automation, refine pan design is critical, as representative and accurate brix of pan massecuite is one of the prime parameters for automation control of a pan. This is best measured and maintained in the pan having cylindrical shell and equipped with mechanical circulator. Floating type calandria pans are more difficult to automate, as the massecuite circulation reduces with increasing massecuite height. Further due to floating calandria installation of stirrer is not possible. As substantial cost would be involved changing the pan design from floating to central down take cylindrical pan with mechanical circulator, it was decided to automate the existing pans. Services of M/s IPRO were hired for the automation of pans. It was an interesting history to share with colleague technologists that how we, the team of IPRO and Mehran Sugar Mills Limited, succeeded to automate floating type calandria pan. Relocation of brix probes, introduction of jigger steam, even distribution of molasses and maintaining higher vapor pressure were the key factors of success. Finally the results were very encouraging and we achieved the desired and anticipated results.

Keywords: Down take, brix probe, circulation, mechanical circulator, jigger steam,

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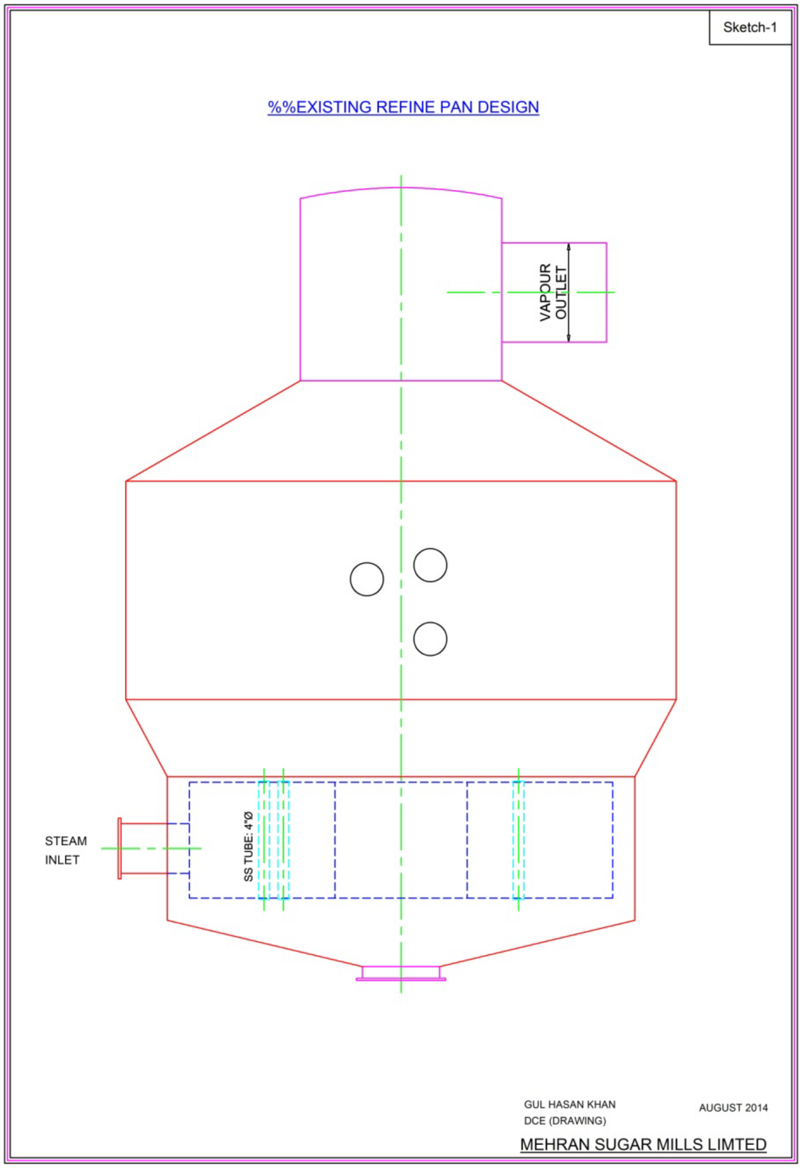
Introduction:-

Mehran Sugar Mills Limited, is one of the biggest project of Hasham Group (Pakistan), having 11,000 tcd capacity. Plant installed in 1968 with initial capacity of 1,500 tcd. Capacity increased to 9,000 tcd by the year 2010, as a consequence of series of plant expansion projects from 1968. Mills crushed 1,140,500 tons in the last season (2013-14). Average sugar recovery for the last three seasons is 10.80. MSM has the defecation process for juice clarification with backend refinery. Talo phosphitation is the refinery process. In the year 2010 it was decided to increase plant capacity from 9,000 to 11,000 tcd, the major limiting factor were the refine pans. There are 04 No. pans for Refine sugar crystallization, each having 60 tons/strike capacity with 242 m^2 heating surface. Instead of adding more pan or replacing existing ones (high cost option), it was decided to increase capacity of existing pans by reducing unwanted water through monitoring, awareness & automation (low cost option). Services of M/s IPRO were hired for the automation of pans. It was the first project of its nature in Pakistan. Methodology was to eliminate unwanted water addition in pans, thus achieving both, the capacity enhancement and the energy conservation objectives. The base case unwanted water addition was 400 t/day. At first instance, water flow meter was installed to measure quantity of unwanted water addition. Only monitoring & awareness reduced it from 400 to 240 tons/day, about 40 % reduction in comparison of base case. The pan design, consisted on floating calandria, was the major issue for successful automation. Many problems and obstacles were observed during the project and successfully resolved to achieve the target. Project took about two seasons for its successful commissioning and finally achieved the targeted capacity and energy conservation objectives.

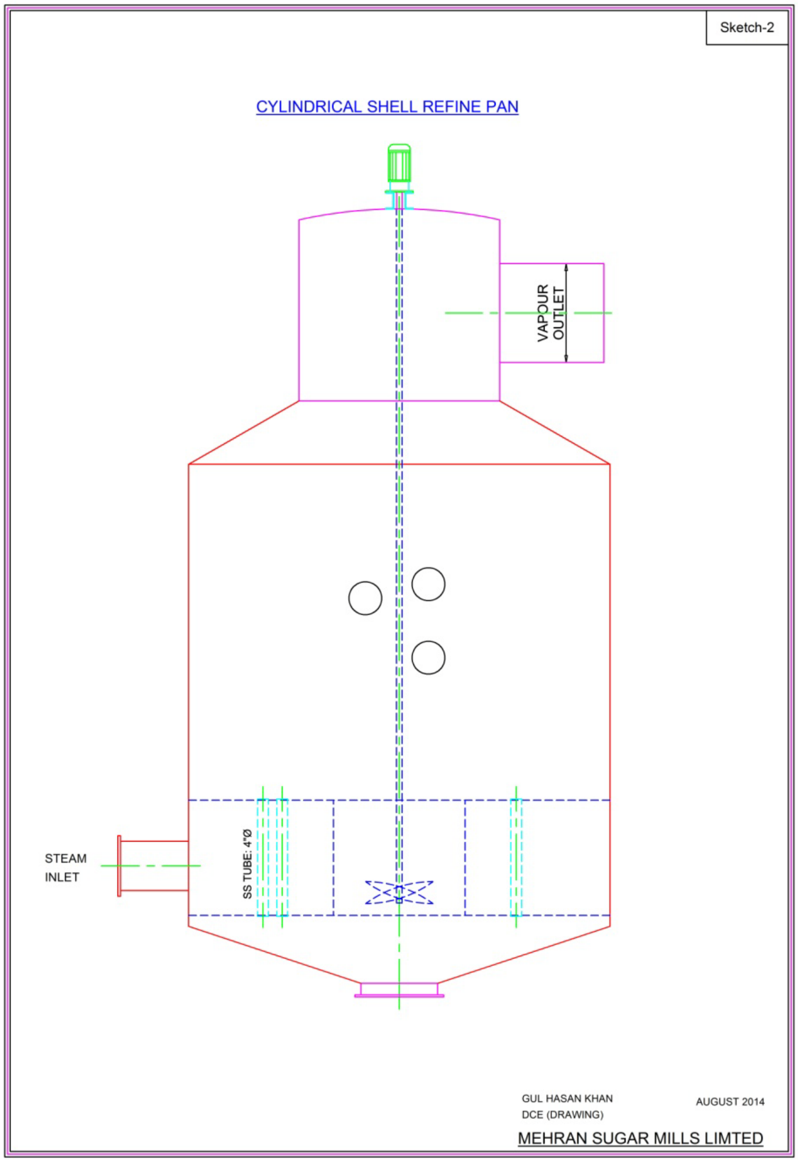
Material & Method.

- The design of refine pan was floating type calandria, with central and lateral downtakes, drawing of floating type pan design is presented as Sketch-1;



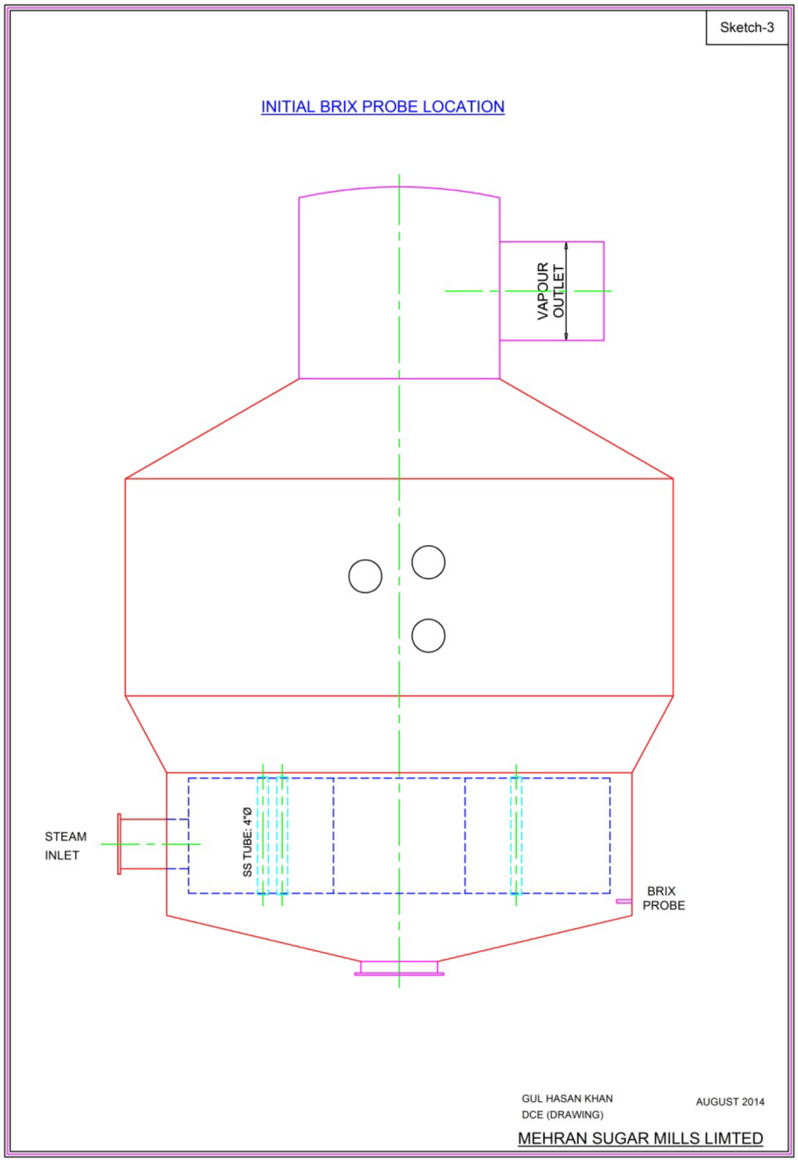
Sketch-1, Design of floating calandria type pan.

- Usually straight cylindrical shell pan with central downtake having mechanical circulator are preferred for refine pan. Since this design provide excellent circulation of massecuite which is critical for good boiling and measurement of representative brix. Drawing of straight cylindrical refine pan is presented as sketch-2;



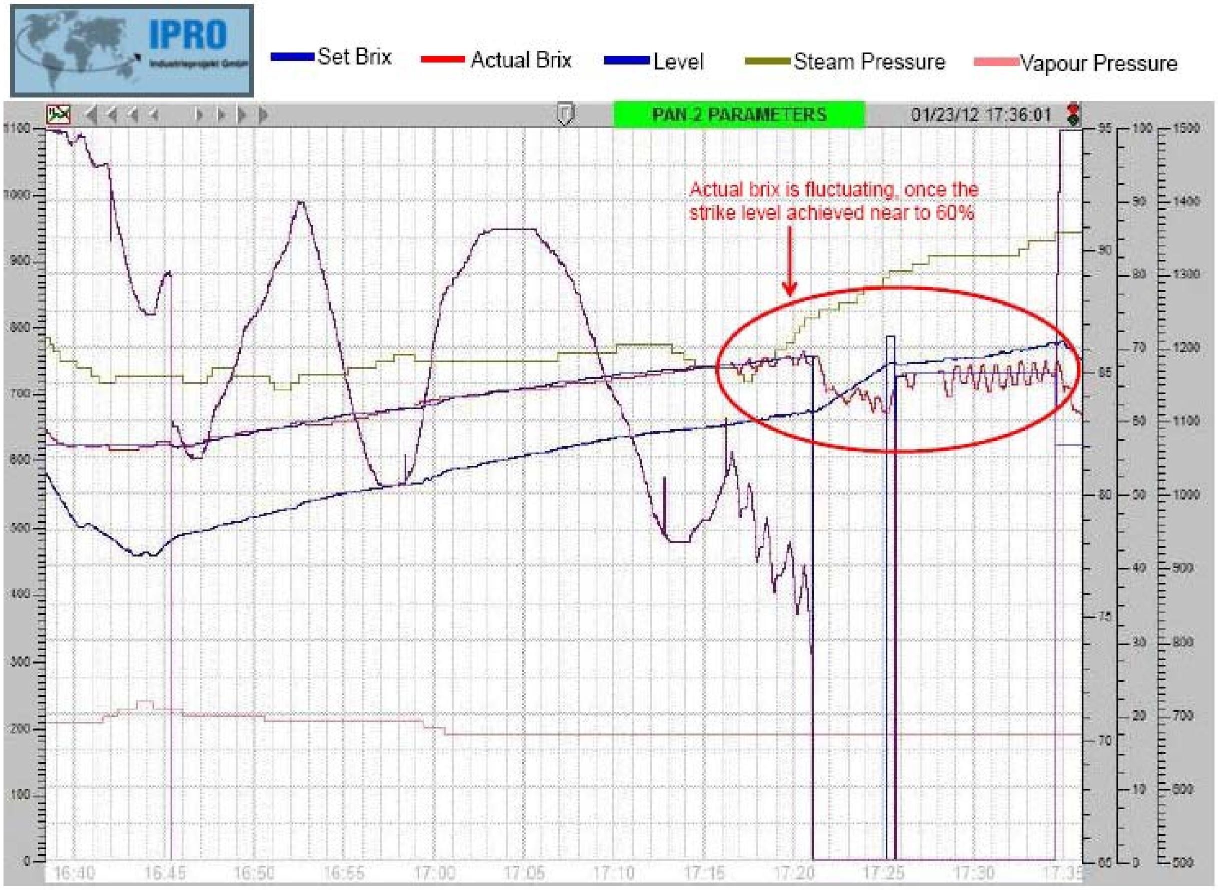
Sketch-2, Design of straight cylindrical shell type standard refine pan.

- The automation was provided with customized solution and sequence of pan operation.
- One of the critical parameters for any pan automation is the measurement of representative brix of material, for which the location of brix probe and massecuite circulation is important.
- Brix probe was initially installed at bottom side of shell under the calandria, see sketch-3 for detail;

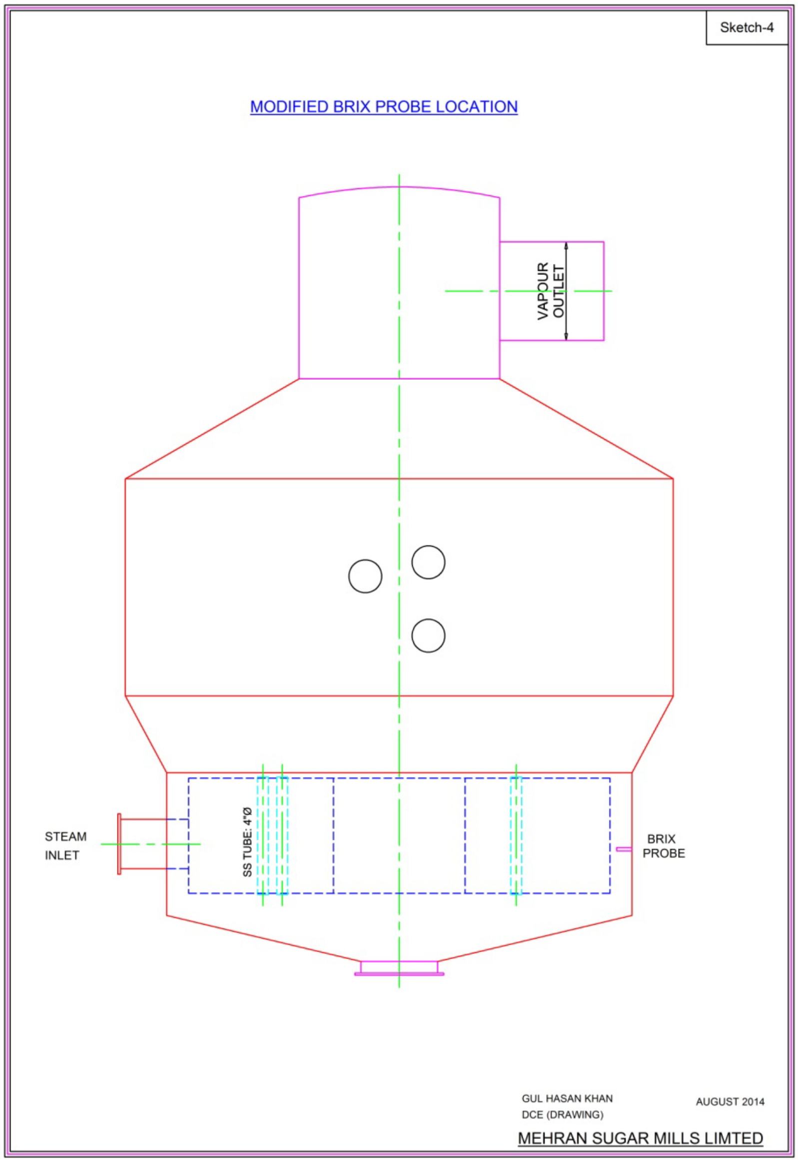


Sketch-3, showing initial location of brix probe.

- As the pan calandria was the floating and without any mechanical circulator, therefore the circulation of massecuite reduces with increasing massecuite level, hence the brix measurement fluctuated whenever pan massecuite height reaches the 60% of the strike level, see following graph of trend showing brix fluctuations at 60 % level of massecuite;



- Further due to the absence of mechanical circulator the only force for massecuite circulation was the buoyancy, which depends on temperature differential of heating vapor and massecuite temperature.
- The 1st vapor (calandria steam) pressure was restricted to 0.3 bar due to the exhaust steam pressure limitation of certain steam turbines of mill house.
- At first place we relocated the brix probe and placed at 40% height of lateral downtake. See sketch-4.



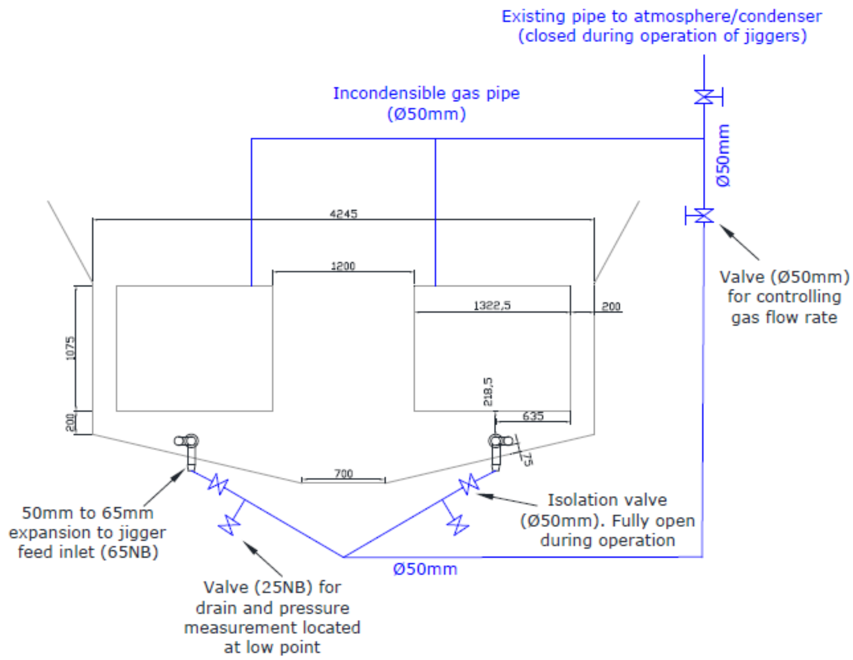
Sketch-4, showing relocation of brix, raising up to 40% height of downtake.

- It gave encouraging response and fluctuations in brix measurement eliminated up to 68% height of pan strike level. Following graph is showing brix measurement fluctuation at higher massecuite level;

- To assist massecuite circulation jigger steam system provided at bottom of pans.
- Non condensable gasses of pan used as jigging medium.
- Two designs of jigger system were introduced at different pans;
  - Laser drilled jigger system of SRI with single coil, in one pan. Detail are given in the following sketch and pic;

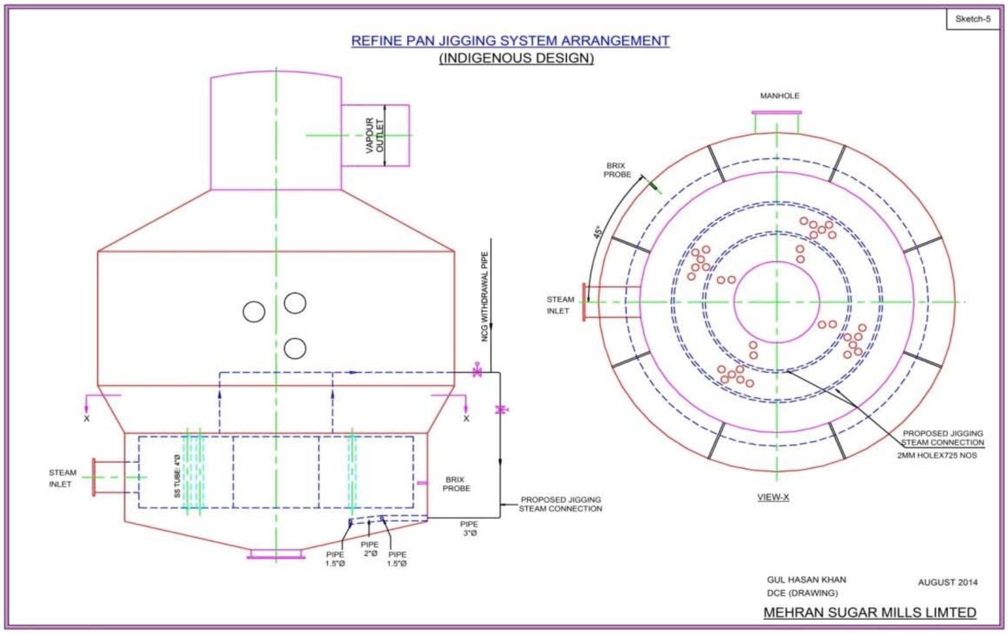
Pic above, Laser drilled SRI tubes for jigging system.

Pic above, showing Laser drilled SRI tubes jigging system installation in pan.



Sketch-above, installation layout of SRI Laser drilled jigging system.

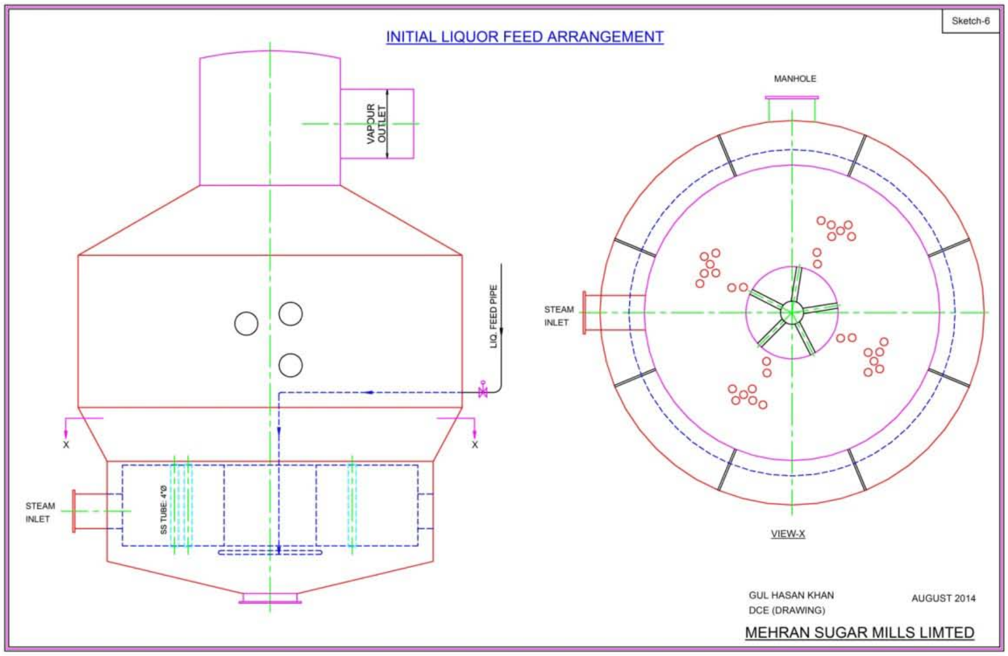
- Indigenous design double coil system installed in three pans. About 700 holes of 2mm dia drilled at bottom side of each coil. Detail is given in the following sketch & pics of indigenous designed jigging system;



<u>Sketch-5 (above), showing installation of indigenous design jigging system arrangement.</u>

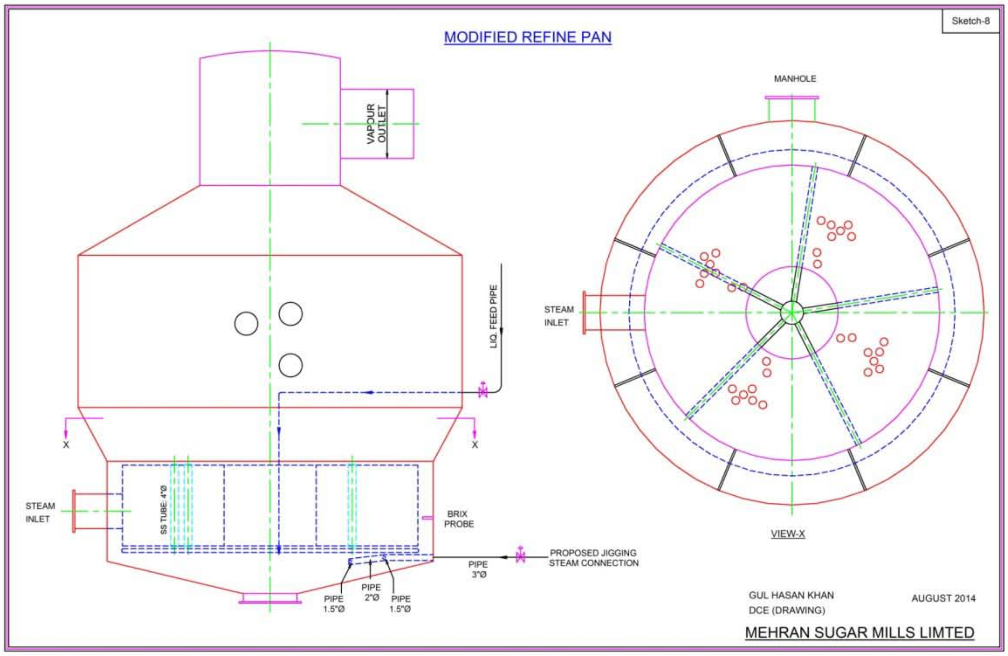
Pic-above, showing indigenous design jigging system installation in pan.

- Surprisingly both the design of jigger system provided similar & encouraging results.
- The calandria steam pressure also increased from 0.3 to 0.4-0.5 bar, this was achieved by increasing exhaust steam back pressure of turbines to the safe limit and auto proportional control of raw and refines pan calandria steam pressure.
- Jigger steam and higher calandria steam pressure improved the massecuite circulation inside the pan, but still there was a problem of lag time in liquor feed and corresponding decrease in massecuite brix measurement.
- The reason of lag time was the improper distribution of liquor feed below the calandria. The feed introduced in the central downtake with six number small distribution pipes. Sketch-6 is showing details of existing feeding arrangement.



<u>Sketch-6 (above), showing existing liquor feed pipe distribution system.</u>

- To improve liquor feed these distribution pipes extended up to the lateral downtake with proportional increase in feed area. This modification eliminated the lag time issue. Sketch-8 is showing modified arrangement extending feed pipes up to lateral downtake.



Sketch-8 (above), showing modified liquor feed pipe distribution system.

Results & Discussion.

- Following is the summary of modifications & alterations in pan design & operation carried out at MSM to successfully automate floating calandria type pan and enhance capacity;
  - Relocation of brix probe from bottom of shell to 40% height of lateral downtake.
  - Introduction of jigger steam using NCG of pans.
  - Increase in calandria steam pressure from 0.3 to 0.4-0.5 bar.
  - Even distribution of liquor feed by proportional increase in feed area.
- Due to the successful, in-house and low cost, modifications we were able to automate pans and to reduce unwanted water consumption by 60 – 70 %, thus increase in pans capacity by 20-22 %.
- The seed and run-off contained fines; therefore a complete elimination of unwanted water could not be achieved.

- Slurry seed system and molasses conditioner will be installed to eliminate remaining unwanted water.
- Finally, due to the successful modifications, we were able to increase plant cane crushing and processing capacity from 9,000 to the targeted level of 11,000 tcd.
- Following table is showing improved results achieved during season 2013-14;

S.#	Description	Unit	Magnitude
1.	Saving of Pan Unwanted water	T/day	260
2.	Corresponding steam saving	T/day	195
3.	Increase in pan's capacity	%	20-22
4.	Pan strikes per day (Base case)	Nos.	41
5.	Pan strikes per day (Modified case)	Nos.	50

Conclusion.

Equipment capacity could be safely increased; to the optimum level, by identifying & defining the problem, investigating the root causes and engineering approach for the cost effective remedy. Indigenous methodology for problem solving is always an option of low cost. Involvement of man at machine is vital for success. At MSM same methodology was applied and successful automation of floating type calandria refine pan was achieved with anticipated results. This is the only example, in Pakistan and probably in the world also, of successful automation of this type of pan, having no mechanical circulator.

Acknowledgement:

I am very much thankful of entire technical team of Mehran Sugar Mills Limited for their untired efforts and dedication for success of the project. I am also thankful of our Resident Director Mr. Ikhlas Ahmed Khan and Managing Director Mr. Ahmed Ebrahim Hasham for their encouragement and guidance.