- **Mirpurkhas Sugar Mills ltd.**

Modern Liquor Refining Technologies for Improved Output and Energy Savings

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Abstract

Sugar Industry always has been looking for the development of adequate Sugar Refining Techniques, having capabilities to manufacture High Quality Refine Sugar with better Steam & Power economies, low cost of production and minimum sugar losses.

There is a critical relation between the sugar quality, steam/power Consumptions and sugar losses in all Refining Techniques.

Almost in all Sugar Refining Processes, either we have to sacrifice on the quality of sugar or to sacrifice on the steam & power economy. We also have to face the sugar losses during the improvement of the sugar quality. The basic purpose of this presentation is to highlight the successive developments in Sugar Refining Technology to improve the quality of sugar and to reduce the cost of production.

It will also guide us to achieve the maximum output at better energy savings.

Unfortunately, Pakistan Sugar Industry has not yet adopted latest sugar refining techniques, those are necessary for achieving high quality and cost effective sugar. Here, we will discuss the developments in various Sugar Refining Technologies, adopted time to time. We will also enlighten the various aspects of different Technologies to evaluate the productivity along with their adverse affects.

Mirpurkhas Sugar Mills has been employing the modern Refining Sugar Techniques for achievement of high standard quality sugar, since last 5 years.

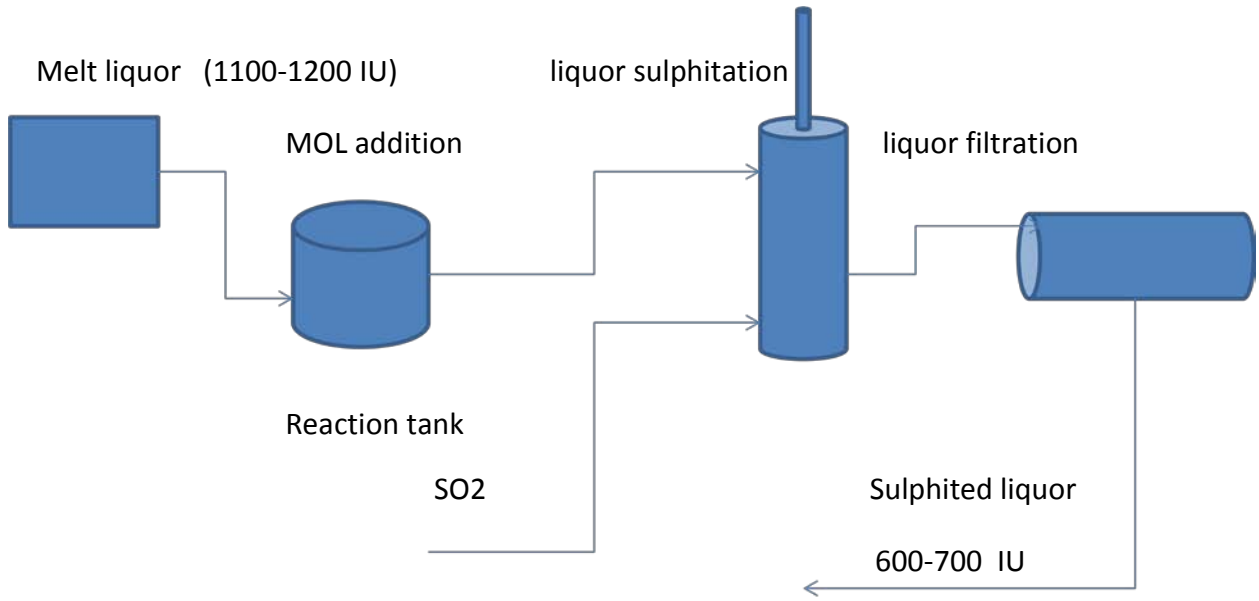
Keyword modern liquor refining technologies, steam/power saving, cost of production

Continue

- Before going to the advance Sugar Refining Technologies, let's have a bird eye view on the old Sugar Refining Techniques. It will help us to understand the benefits of new and advance Sugar Refining technologies.

Process Description of Defecation Remelt Sulphitaion DRC.

- In early 70s, world was producing refine sugar through Remelt Defecation Sulphitation process. A brief out line of process is given below
- In Defecation Remelt Sulphitation Process, raw melt was treated with lime to increase pH of melt 7.3-7.5, and then it was treated with SO2 gas. PH of melt coming out from Sulphitation Tower was maintained at 6.2-6.3. After Filtration, melt was sent for pan boiling.



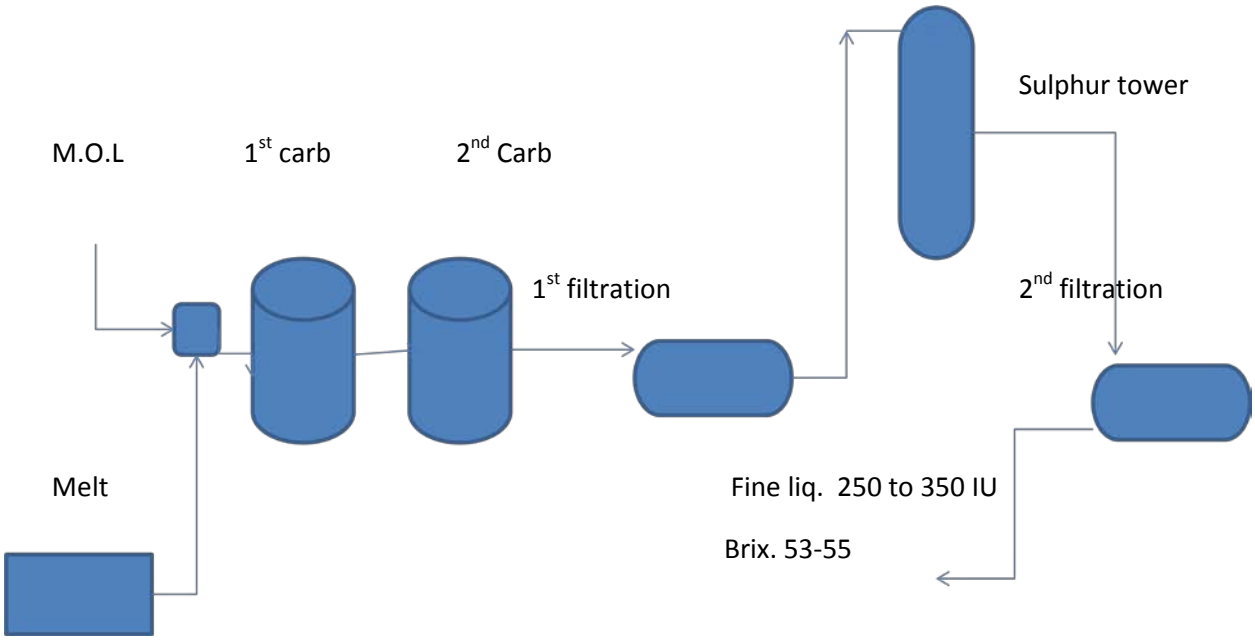
- **<u>Process advantages / disadvantages of DRS Process</u>**

  Advantages

- Easy processing
- Low Cost Refine Sugar production

- **<u>Disadvantages</u>**
- High sulphur contents in final product
- High color of sugar > 70-80 Icumsa
- Low stability of sugar quality

After few years, this process was converted into Remelt Carbonation Sulphitation Process (DRCS). Process flow and a brief out line of DRCS are shown below.



- **DRCS Process Description**

➢ Addition of CaO in melt liquor @ 55 brix to increase pH 10.5-11.0.

➢ 1st Carbonation out –let liquor pH is 9.0-9.5.

➢ 2nd carbonation out -let liquor pH 8.0-8.2.

➢ Filtration of carbonated Liquor and then sulphited to pH 6.4-6.6.

➢ The Sulphited liquor is filtered and sent to refinery pans as fine liquor.

- Major Drawbacks:

- Due to the inefficient carbonation system , un -reacted lime remains in liquor which effects the quality of sugar and also creates filtration problems.
- Brix of raw liquor is maintained at 55o to avoid filtration problems.
- Low Brix of carbonated melt increases steam consumption at Pan station.

Advantages

- Acceptable color of sugar (< 50 IU of R1)
- acceptable product stability

Disadvantages

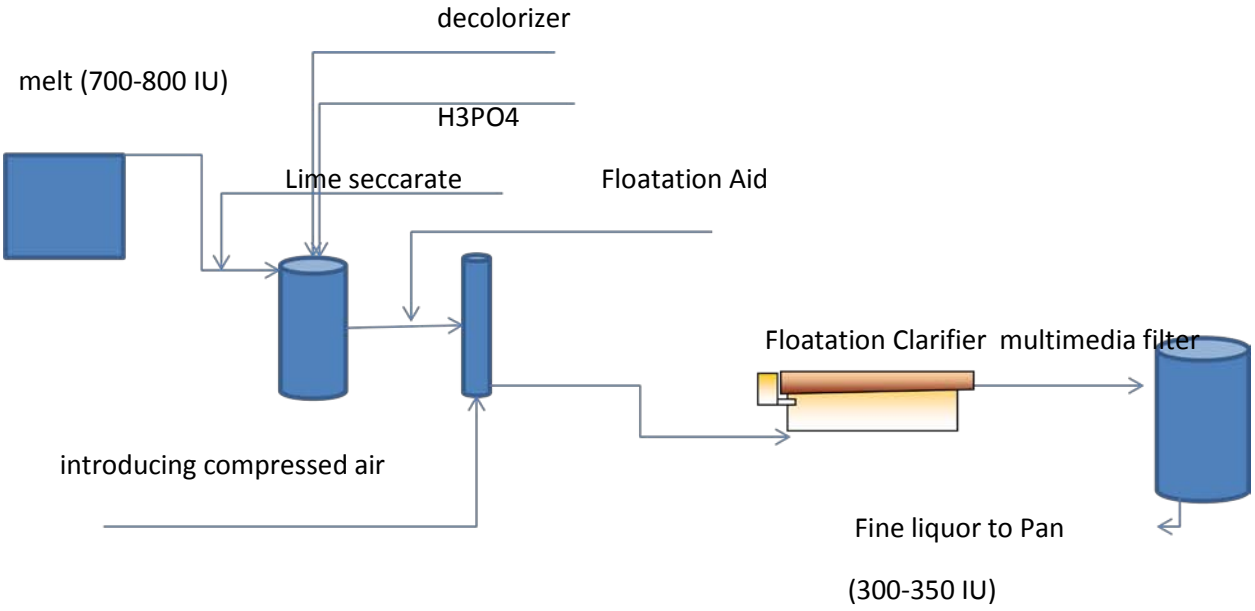
- High sulphur contents in final product
- High steam Consumption
- High electric Power Consumptions.

DRP (Defecation Remelt Phosphatation)

- In order to solve the issue of conventional carbonation system, a new Sugar Refining Process named as DRP (Defecation Remelt Phosphatation) was introduced. A brief out line of this process is given below.
- **Description Of DRP Process**

After heating of Raw melt to 85 C, Lime saccharate is added to increase its pH to 7.6 – 7.8. Heated Melt is sent to reaction tank after the addition of decolorizer and Phosphoric Acid @ recommended dose on melt solid. Then treated melt passes through aeration tank after the addition of floatation aid. Finally, it goes to Floatation Clarifier. Precipitate floats to the surface of clarifier and clear liquor liquidate from the bottom coils of clarifier.

- **Process flow of DRP**



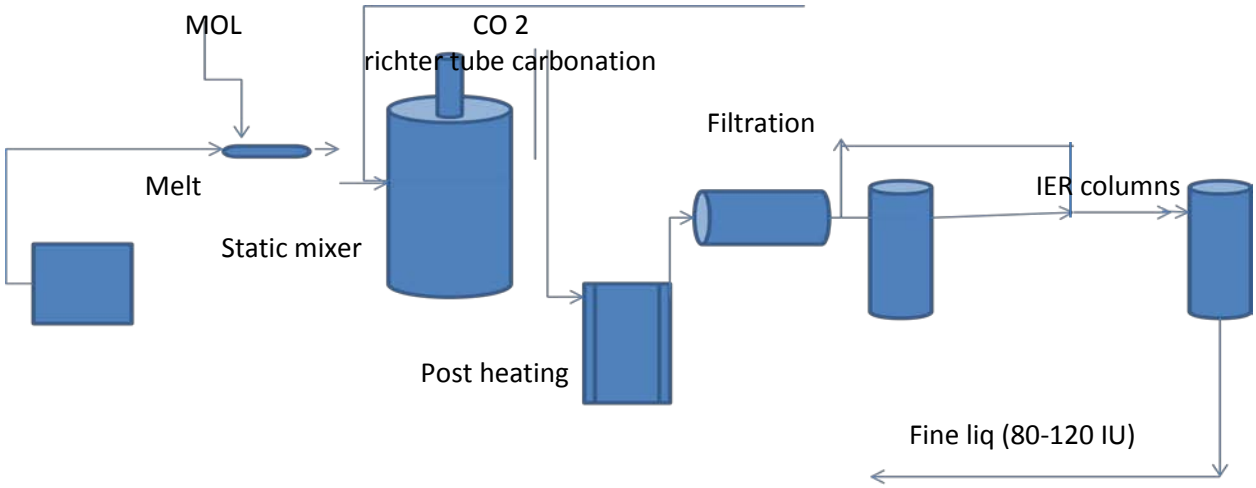
- **<u>Process advantages /disadvantagesof DRP</u>**
- **Advantages**
- Acceptable Sugar quality
- Low Power Consumption
- Low steam Consumption
- **Disadvantage**
- High cost of production due to addition of various chemicals. But DRP process is still cheaper if we compare it with Defecation Remelt Carbonation Sulphitation Process.
- **<u>Modern, energy and cost effectivesugar refining technology</u>**
- Now, we will discuss Modern Refine Sugar technology for the production of high quality sugar.

At present, 02 process are in practice for the Production of High quality Sugar

1. Clarification of Melt through Carbonation and further declorozation with IER

2. Clarification of Melt through single stage Richter Tubes Carbonation reaction system and further decolorization with PAC (Powder Activated Carbon)

Carbonation with IER process flow



IER selection

Decolorization with Ion Exchange Resins

Ion exchange resins are strong base anionic type decolorizer used in the sugar industry . By nature , resins are quaternary amine functional groups. They are operated in the chloride form.

IER composed of one or two types of polymeric material. Polystyrene are hydrophobic matrix and polyacrylic are hydrophilic. Some Refineries are using one type of resin, while others are usually using acrylic followed by styrenic for polishing. The acrylic resin removes large molecular weight colored compounds which tend to foul the styrenic resin, providing good protection to the polishing resin. Acrylic resins can be completely regenerated with sodium chloride solution even a dark regenerant effluents from styrenic resins can be used to regenerate acrylic resins.

Styrenic resins are more prone to fouling by organic compounds than acrylic resins and need occasional acid regeneration. Also, their decolorization capacity is higher than that of acrylic resins, but the color is not so efficiently removed during regeneration and capacity can drop rapidly if overloaded.

Styrenic resin types are favored when the inlet color is on the low *end and acrylic types when it is higher. Numerous plants today operate*

with a combination of both types, which is advisable when the inlet feed color fluctuates

(ref. purolite)

- **Table 1:** compares the color removal efficiency of adsorbents for various color compounds. (ref. purolite)

% of Component Removed by Adsorbent			
Components	Carbon	Styrenic SBA	Acrylic SBA
Total Color	78	83	65
Color > 20 kDa	62	83	55
Phenolic Colorant	70	50	50
Polysaccharides	20	30	25
Starch	16	15	20
Dextran	30	40	10

Advantages/ disadvantages of Carbonation with IER Process

- **Advantages**
- High color removal
- Good quality sugar (< 20 IU)
- Low operational cost
- **Disadvantages**
- High capital cost
- high regeneration time and typical regeneration process
- High rinse water requirements
- Sucrose Inversion

Another Modern technique is “Melt clarification with single stage Richter tube carbonization reaction system followed by the application of high efficiency adsorbent (PAC) for further decolonization “

- **Melt clarification with Richter tube carbonation and further decolorization with PAC**

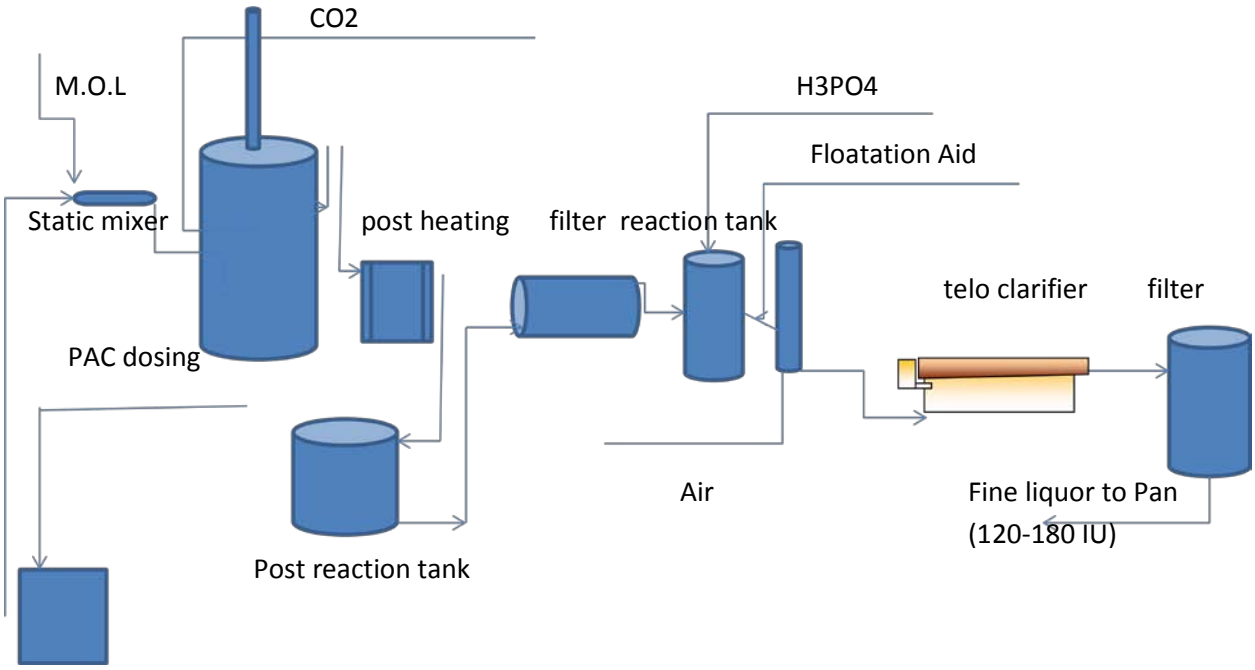
- Richter tubes Carbonation systems is suitable for high brix melt solution. Like conventional carbonation process ,Co2 gas is introduced in the reactor to mix with lime containing liquor. Many physico-chemical reactions take place. In the reactor, formation of calcium carbonate and some other precipitate occur.

- Richter Tube

The concept for such gassing tubes was determined many years ago, and has more recently applied to new and existing purification systems. In MSM three tubes are installed in a single gassing tank with slots cut into their undersides. Protruding through the slots are wiper arms which are slowly driven back and forth to prevent scaling encrustation (Figure 1). These tubes are aligned under a central circulation cylinder, so the fine gas bubbles are discharged and cause a natural uplift to the melt. This combination of tubes and cylinder create up to a 10 fold internal circulation and giving excellent gas utilization and a homogenous final liquor.

- **Figure 1**

Process flow melts carbonation with PAC



Application PAC

PAC is used in continue flow prior to Carbonation, but for best results added at or just after the Melt Station, with 10-20 minutes contact time till it reaches Carbonation, PAC is extremely efficient in decolorizing Sweetwater, permanently removing a significant portion of sweet water colour, thereby reducing melt liquor colour and achieving improved total process efficiency.

Advantages of PAC

- High flexible and easy application
- High capability for color removal
- Increase washing cycles
- Less sweet water generation
- high process capabilities, maintained CPK values as 1.35 though out the period.
- Cost effective as compared to other decolorizers
- Better quality of final product
- Improved filterability

Results comparison

Particulars	Average Color (m,a,u)		
	DRC with phosfloatation	DRC with Phosfloatation and PAC (50-100 ppm)	% reduction
Fine Liquor	220	180	18.2
R-1 Sugar	24	20	16.7
R-2 Sugar	38	33	13.2
R-3 Sugar	55	48	12.7

Process capability

- The IER with single stage Richter tube carbonation Process is valuable for the production of High quality refine Sugar but Melt Carbonation with Richter Tubes and then Treatment with activated Carbon is more feasible as this process is capable to produce good quality sugar (< 20 Icumsa) with better Steam Consumption , less Capital investment and low operational cost.
- Please see the results, cost and energy/steam comparison between different Process.

Basic data for cost comparison

- Cane = 300 TCH
- Melt solid 38 T/h (12.6% Cane)
- Refine boiling at vapor-1
- Decolorizer and H3PO4 consumption 300-350 ppm (for DRC process)
- Bagasse to steam ratio 1:2
- IER shelf life 5 season

Per ton sugar Approx. cost comparison of deferent process based on chem consumption and energy requirements.

Process	Elect cons. /ton sugar	Elect. Consum, KWH	Melt brix	Melt qty	Extra steam /vapor requirement /ton sugar	Chemical consumption R.S per ton of Sugar								Extra elect/ steam RS	Grand total RS	Color of R-1 Sugar
						Decolorizer	H_3PO_4	Sulphur	PAC	IER	Regenration chem Rs	Float. Aid, Misc	Total (chem)			
DRP	2 kWH	58	65	58		170	36	0	0			5	**211**		211	30-40
DRC-with phosfloatation and PAC (richter tube single stage carbonation)	6.5 kWH	200	63	60	0.048	0	23	0	38			5+30	96	45 + 47	188	18-25
DRCS	7.5 kWH	230	55	70	0.28	0	0	20	0			0+30	50	54 + 285	389	30-40
DRC with IER	6.5 kWH	200	63	60	0.048					58	70	0	128	45 + 47	220	<20
Bagasse price=2000 RS/ton																
PAC consumption 100 ppm on Sugar																

Melt Concentration:

- if we intend to concentrate fine liquor in some concentrator / Evaporator, We have to increase its pH to avoid the sugar loss at high temperature. Due to higher pH and Temperature of melt its color can be increased by 15-20 %.

- It is more advantageous to concentrate fine liquor that's obtained from carbonation and its further decolonization with IER or high efficiency adsorbent (PAC) as it has low color and we can easily tolerate the impact of high pH and temperature in concentrator as compared to other process. We can easily increase liquor Bx. from 62 to 72 and can get around 2% steam saving on cane,

Conclusion

- Color removing capability of DRC (single stage Richter tube carbonization reaction system) followed by PAC decolorization process is approximately 70-78%. Since, this technique is capable to get the filtration with high melt Bx, which means the main advantage regarding steam consumption at Pans in DRP Process over Conventional Carbonation has been neutralized. We are producing high quality sugar with Richter tube carbonization reaction system followed by PAC decolorization process at MSM which is more cost effective as compared with any other process and the advantage of liquor concentration over DRP process will be additional.

Acknowledgments

At the end, I would like to thankful to "Almighty Allah", who made me capable to present this paper at the forum of PSST in front of intellectuals . I am also thankful to the Management of MSM, who gave me chance to present this paper. I am thankful to Mr. Syed Mohammad Ali & Mr. Tahir Bashir for technical and moral Support.

Mr. tahir Bashir is also going to deliver a presentation on the same topic in Sugar Asia Conference Indonesia with some more details, these details can also be shared with PSST members later on.

Thank you