Advance Design and Operation of Vacuum Filter

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Abstract:
In Off Season 2010 Ranipur Sugar Mills done R &D work at 9 x 18 ft Vacuum Filter to increase its work efficiency and capacity. It was resulted to design a vacuum filter, called as RSMT* designed vacuum filter, capable to operate at two fold capacity as compared with other designed Vacuum Filter available in the local market with comparable technical results . The Paper has presented detail of technical work carried out regarding equipment design and its installation for operation. Paper presentation also included the achievement of four years technical results at capacity operation of the RSMT designed Vacuum Filter.

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Key words: Vacuum Filter, BMR, mud pol, vacuum zones, un-soluble matters, tcd and tch.

1-Introduction:

In 1998,Current Management taken over the charge of Consolidated Sugar Mills and re-started it with new name of***Ranipur Sugar Mills (Pvt) ltd,***It has capacity of 4000 tcd. At Vacuum FilterStation two FCB designed vacuum filters of 9x18 ft size are installed. Till crushing season 2009-10, at normal crushing level both filterswere remained in operation.During off season 2009, it was decided to do BMR activitiesat Vacuum Filter Station. In follow up all kind of line sizes, vacuum leakages in the system, Cascade condenser design and its leg sealing height, high and low vacuum juice collection and separation tank sizes and their sealing leg height were thoroughly examined and done all the best. Check up and maintenance of vacuum pumps was carried out as per standard design parameters. During season 2009-10, standard operating practices and procedures were followed and maintained though out the season. With the all good efforts, mud pol on the average for the season was reduced from 4.36 % to 3.03 % as compared with the average of previous 3 seasons.During running season 2009-10 many other bottle necks hindering in the reduction of the mud polwere also, observed, as listed below:

i- High vacuum problem:

With the operation of two vacuum pumps, high vacuum could not maintain constantly at 16-18 in of Hg . It was due to the Teflon made header plates, which when tightened with vacuum filter header, itsdeflection caused vacuum short circuiting within the header tubes and vacuum leakages from open air sideto the header.

ii- Less quantity of washing water:

It was also observed that drum not absorbed such quantity of washing water which wasnecessaryto reduce the mud pol loss. One reason of that is mentioned in “a” and other wastheabout 500 mm surface length on both ends of the drum where washing water was not penetrated in the mud layer.

iii- Less percentage of High Vacuum Zone:

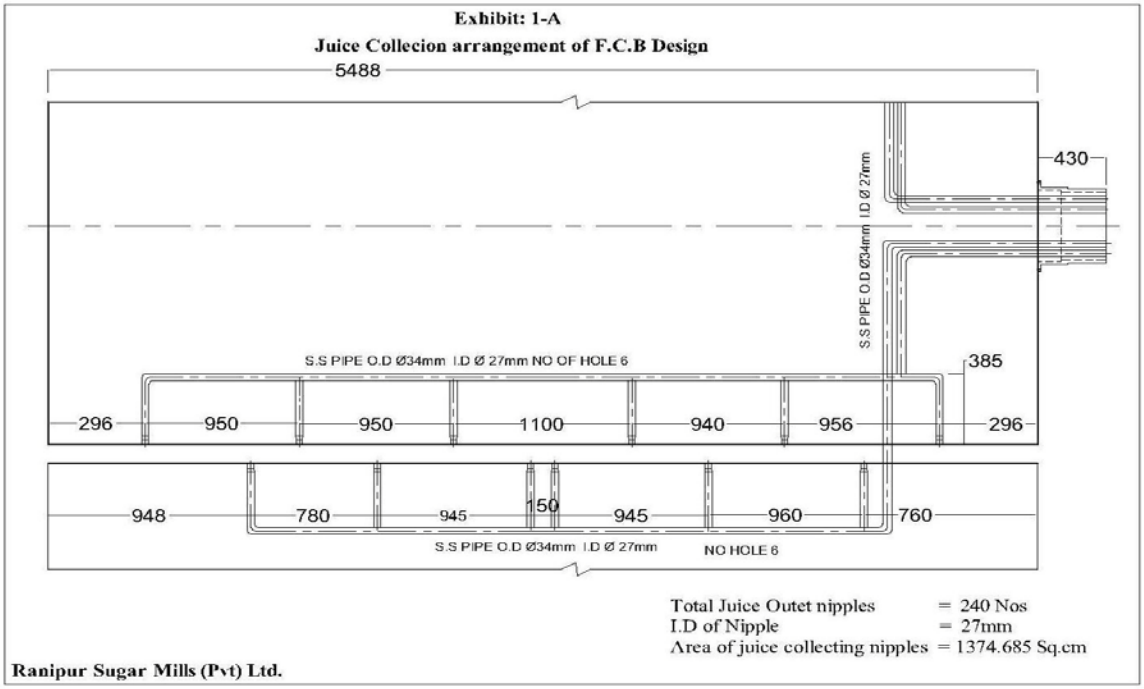
Mud conveyor belt was placed on the working floor and working floor and plate- form was made over the belt conveyor. The mud scrappers,for convenience of the working staff, were placed at reasonable height from the working plateform.

2-**Material and Methods:**

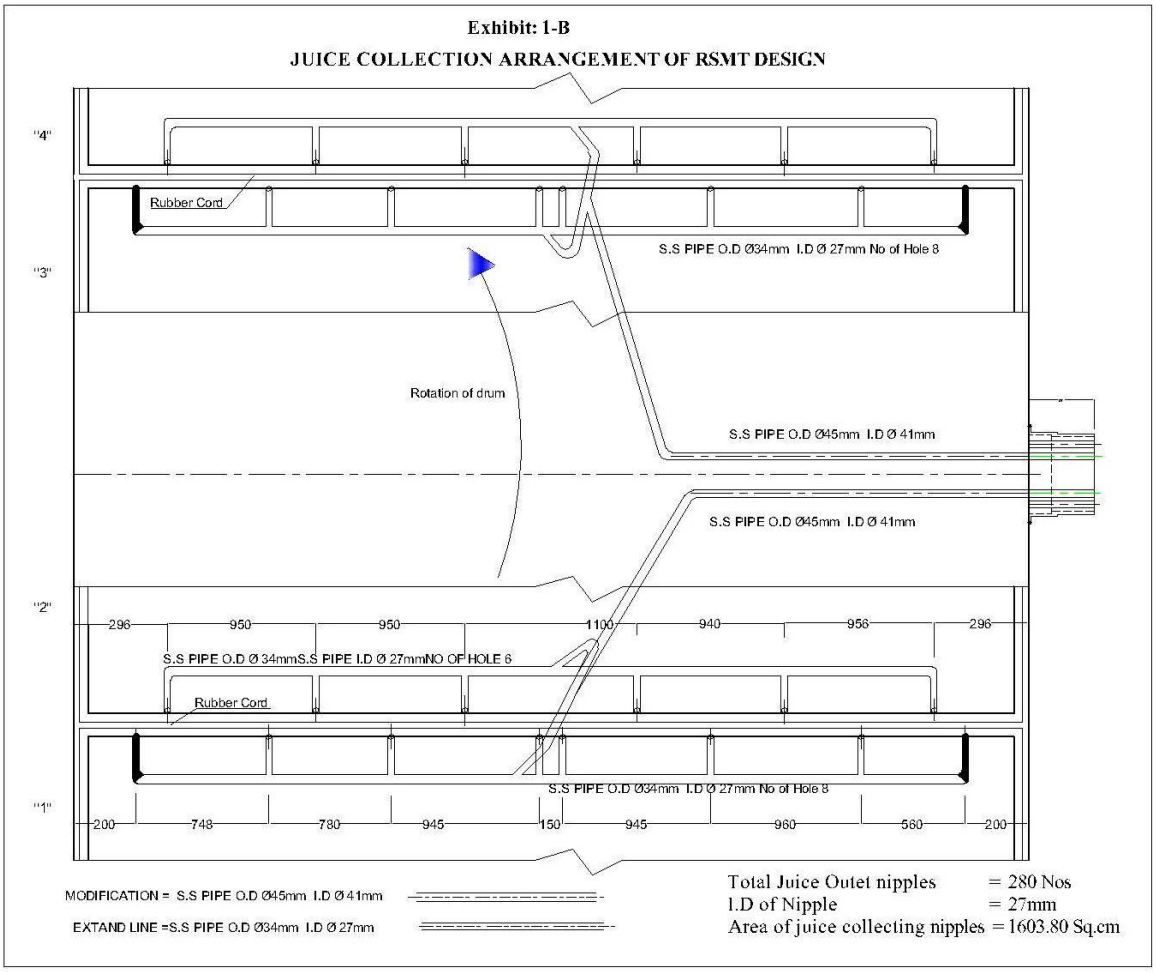
At the end of the season 2009-10, in the light of the above mentioned observations, following decisions were made and executed in off season 2010.

i- Redesigning of the juice collection system

In FCB designed juice collecting system, there are forty screen lengths of 435x 2700 mm sizes. Two screens are fitted in line parallel to drum length, holding with rubber cord at the radial center of the drum,making twenty screen lengths each of 435 x 5400 mm round the drum. For fixing these 20 length screens, twenty segments are made at the drum with rubber cord fixing channel arrangement. In each segment there are 6 up and 6 down juice collecting S.S nipples, each of ID 27 mm. Up and down nipples are connected with individual header of ID 27 mm. Theses 40 nos. headers are connected to vacuum filter header. Arrangement is shown in Sketch No. 1-A



In RSMT Juice collection system of vacuum filter, there are 6 up and 8 down juice collecting nipples each of ID 27 mm. Up and down nipples have separate header of ID27 mm. Upper header of one segment and down header of 2nd consecutive segment are connected with main headerof ID41mm at the center of the drum. There are 20 nos. main tube headers. Each tube header is routed to main vacuum filter tube plate header. Juice Collection Arrangement is shown Sketch No. 1-B



ii-**VacuumFiltersheaderand brasstube plates.**

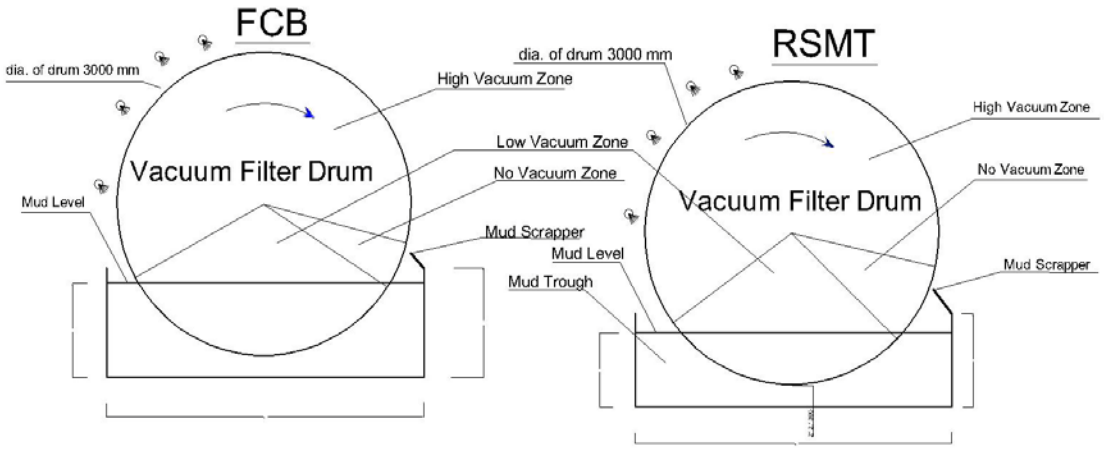
In FCB design, there were 40 tube holesin steel header, each of 34mm diameter, covered with same size Teflon plate. As low & high vacuum distribution header is very important part of the filter, for RSMT designed vac. Filters headersfor both along with tube plate and vacuum zoneadjustment plates were purchased from private manufacturer.

iii-Shifting of mud belt conveyor beneath the working plate form

This was just a Mechanical dismantling and re-erection job which completed in the off season 2010.Due to shifting of mud conveyor belt below the working floor no vacuum, low and high vacuum zones were re-adjusted as shown in Comparison of Vacuum Zones Sketch No.3

Sketch No.3

Comparison of Vacuum Zones for both filters



Vacuum Zone	Filtering Area FCB		Filtering Area RSMT	
	%	Ratio	%	Ratio
No Vacuum	7.50	1.00	10.00	1.00
Low Vacuum	25.50	3.40	20.00	2.00
High Vacuum	67.00	8.93	70.00	7.00

2.i-Trial of New designed Vacuum Filter

To control vacuum leakages, Head plates and vacuum adjustment zone plates of filters were polished in fixed position at vacuum filter headers by drum rotation in off load position. RSMT vacuum filterswere trialed one by one at the start of the Season 20010-11.

Annexure No.1 shows the technical results of single RSMT vacuum filter for the trial run of 24 hrs. Three tests were conducted with the interval of 8 hrs at average crush rate of 165 tons/hr.Last column shows the average test figures. Average mud pol for season 2010-11 was 1.93 %.

Annexure No.1

RSMT designed Vacuum Filter Trial Report

Sr. No.	Description	Unit	Test #1	Test#2	Test #3	Average
1	Avg. Crushing rate	tons/hr	165	165	165	165
2	Vacuum Filter Drum					
	i-Size (diaxlength)	ft x ft	9 x 18	9 x 18	9 x 18	9 x 18
	ii.Net Surface Area	Sq.ft/Sq.m	504/46.82	504/46.82	504/46.82	504/46.82
	iii.Rotation	mpr/rph	3.27/18.35	3.75/16.0	3.00/20.00	3.34/18.12
3	Mud discharge rate	tons/hr	4.72	3.93	5.09	4.57
4	Vacuum					
	i. High	In of Hg	16-18	16-18	16-18	16-18
	ii- Low	In of Hg	8-10	8-10	8-10	8-10
5	Washing Water					
	i-Temperature	^{O}C	85	85	85	85
	ii-Flow	Lts/hr	7755	9900	6600	8085
	iii-Percent cane	% cane	4.7	6.0	4.0	4.9
	iv-Percent mud	% mud	164	252	130	182
6	Mud Feed					
	i-Temperature	^{O}C	70	72	72	71
	ii-Brix	%	12.0	11.0	11.5	11.5
7	Mud Cake Thickness	mm	7.0	6.0	7.0	6.6
8	Mud loading	Kg/sq.m	5.49	5.23	5.44	5.39
		Kg/sq.m/hr /cm thick	143.9	139.5	155.4	148.0
9	Unsoluble matter % mud	%	4.0	No data	No data	4.0
10	Moist.% mud	%	77.5	No data	No data	77.5
11	Mud Pol%	%	2.40	1.50	1.90	1.93

2.ii- <u>Comparisonof Design/Control Parameters with E.Hugot Recommendations:</u>

Annexure No.2 is self-explanatory. Where for 4000 tcd Plant, single RSMT designed vacuum filter of size 9 x 20 ft with 2000 m^3/hr vacuum pump is recommended, where asE.Hugotrecommends two vacuum filters of size 9 x 20 ft with vacuum pump of 3150 m^3/hr.

Annexure No. 2

Comparison of Design & Operating Data

Sr. No	Description	Units	RSMT design	E.Hugot Recommendation *
1	Vac.Filter area per TCH	Sq.ft./tch	10.8**	6.0
2	Drum rotation	Rph	16-20	7.5-10
4	Mud cake thickness	Mm	6-7	7.0
3	Mud loading rate	Kg/Sq.m/hr/ cm thick	148	125
5	Washing water temperature	^{O}C	85	88-90
6	Washing water %Cake	%	150-200	100-150
7	Mud feed temperature	^{O}C	70-72	85.0
8	Moisture % cake	%	75-80	75-80
9	Vac.Pump requirement	$m^3/m^2/hr$	12.4	Ordinary Oliver 12.8 and Rapifloc Oliver 31 - 32
	(m^3 air /hr/ m^2 open area/hr)			
10	Vac. Requirement			
	i.High	In of Hg	16-18	16-20
	ii. Low	In of Hg	8 -10	8 -10
11	Un-soluble matter % dry mud	%	4.0	6.0
12	Mud pol %	%	1.5 – 1.9	1-2
13	Recommendation for 4000 tcd			
	i.Vac.Filters(Dia x length)	Nosx(ft x ft)	1 x(9 x20)	2 x(9x20)
	ii.Vac.Pump Capacity	m^3/hr	2000	3150

*****Hand Book of Cane Sugar Industry,3rd edition,E.Hugot,page 477-488.

** based on 19.64 % open area of Vac. Filter screen.

3-Results and Discussion

i- Annexure No.3shows gradual improvement in control ofmud pol losses for the trial season 2010-11 of RSMT designed vacuumfilters. Average mud pol for 1st 30 days was 2.03which with gradual control during season endstoaverage of 1.53 % for last 33 days of the season.

ii- Annexure No.4 shows eight seasonsmudpol losses, four for before and four for after the redesigning and operation the RSMT designed vacuum filters.In season 2006-7, 2007-8, 2008-9, & 2009-10 it was 4.47, 4.28, 4.34 and 3.03 respectively where as with RSMT vacuum filter it was in season 2010-11, 2011-12, 2012-13 and 2013-14 as 1.72, 1.87,1.95 and 1.96 respectively.

iii- Addition of 40nos. extra juice collection nipples at drum of RSMTvacuum filter, increased the juice collection area of the drum to 16.67 % than FCB vacuum filter.

iv- There was 15.30 %increase inx-area of RSMT vacuum filter header tubes as compared with FCB vacuum filter header.

v- 3% increase in High Vacuum Zone at RSMT vacuum filter was observed by shifting mud conveyor belt below the working plate form.

vi- In RSMT design, the connection of common juice collection header No. 20, of ID 41mm at the center of two adjacent segments

headers facilitated juice flow from both ends to the center of the drum where in FCB design as shown in Sketch No.1-A, juice collecting header isof same ID that of individual nipples of 27mm and through which collected juice flows from one end to other end of the drum to join the main vacuum filter header.

vii- Brass made header plates of RSMT design prevented the vacuum short circuiting within the header tubes and leakages from the outside of header.

viii- Points listed in Sr. no. iii to vii resulted in the improvement of vacuum control of the filter and encouraged to increase the quantity of the washing water.

4-Conclusion:

At Ranipur Sugar Mills, the performance of the RSMT design vacuum filter remained excellent without any waver and doubt through all seasons from 2010-11 to 2013-14. Only single filter with single vacuum pump was remained operative inthe season. It cut off the demand of 81.7 kw electric power by shutting of 2^{nd}Vacuum Filter and 2^{nd} Vacuum Pump and three casual workers . The detail of 81.7 Kw electric power includes75 Kw vacuum pump motor,4.5 Kw drum motor and 2.2 kw mud tray stirrer motor.

5-Recommendations:

For flexible operation of newly installed Sugar Plants,author recommend only single RSMT designed filter of 9 x20 ft and singlevacuum pump of capacity 2000m^3/hr for every 4000tcd. The running Plants can also do the same with existing filters by adopting RSMT design.

6-Benefits:

Ranipur Sugar Mills saved 254.9 Mw power and three manpower for average season length of 130 days by operating single Vac. Filter & Vac. Pump and putting off 2^{nd} Vacuum Filter and 2^{nd}Vacuum Pump.Financialbenefitsof RSMT vacuum Filter are shown in Annexure No.5

Annexure No. 5

Financial Benefits of RSMT designed Vacuum Filter for average Season of 130 day

Sr.No.	Description	Units	Quantity	Cost per unit (Rs.)	Total Cost (Rs.)
1	Electric power	Kw	254,900	-	-
2	Bagasse*	Tons	1,529.4	2,200	3,364,680
3	Man power	Nos.	3	52,000	156,000
4	Estimated maintenance cost of single vac. filter	No.	1	150,000	150,000
5	Total Financial Benefits**	-	-	-	3,670,680

*Bagasse saving based on consumption of 12kg steam per Kwhr generation and 1.0 kg bagasse for production of 2 kg , 23 bar steam.

** Sugar saving of RSMT design as comparison with FCB design not included.

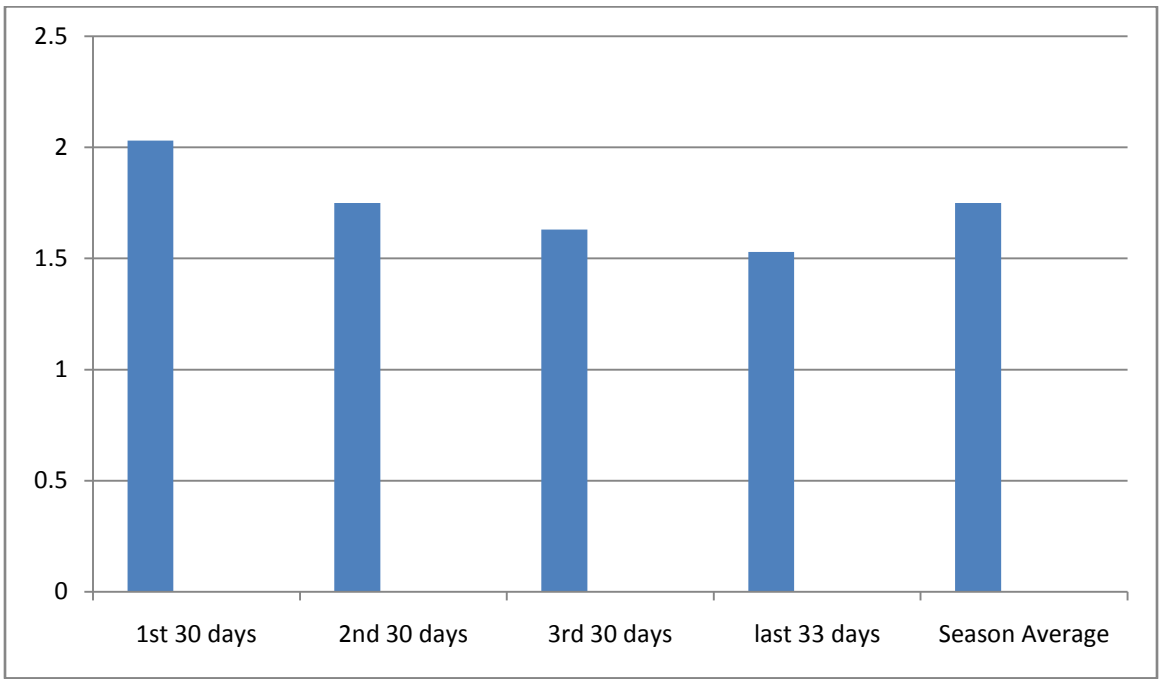
Annexure No. 3

Mud pol control trend for Season 2010-11

(Ref: Daily manufacturing Reports,season 2010-11)

1st 30 days	2nd 30 days	3rd 30 days	Last 33 days	Season Average
2.03	1.75	1.63	1.53	1.72

Bar Chart Presentation



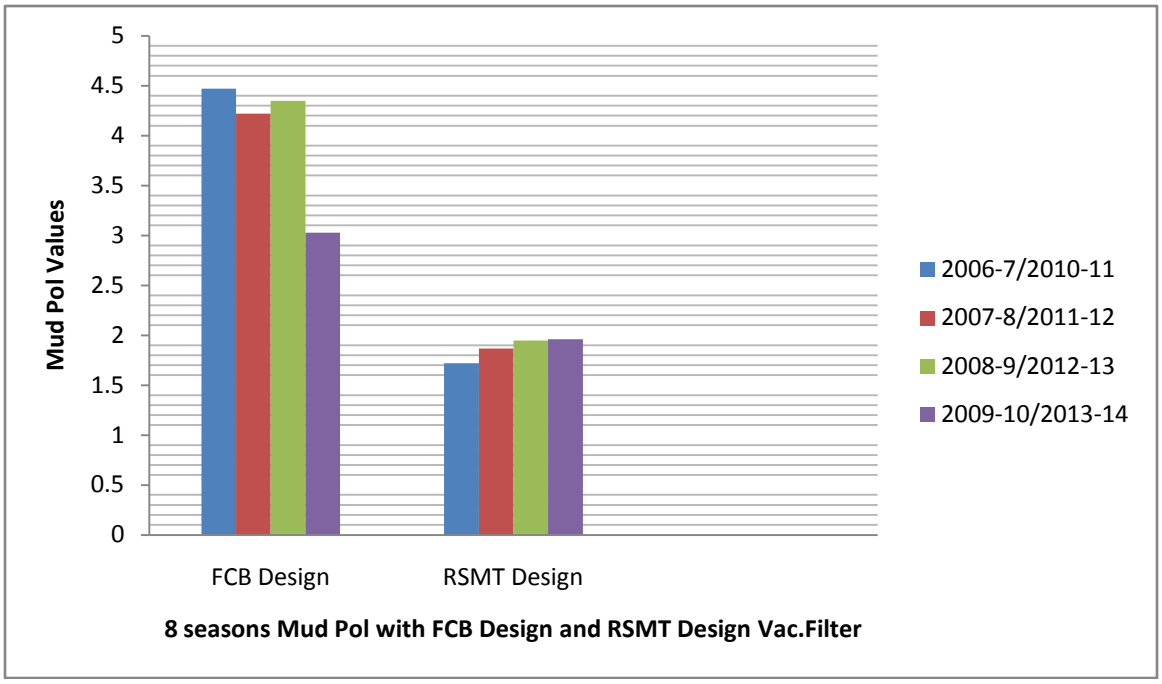
Annexure No.4

8 Season Mud Pol Comparison

(Ref: RT4 Final Reports as listed seasons)

FCB Design with 2 V.F Operation				RSMT Design with single V.F Operation			
2006-7	2007-8	2009-9	2009-10	2010-11	2011-12	2012-13	2013-14
4.47	4.28	4.34	3.03	1.72	1.87	1.95	1.96

A-Bar Graph Presentation



6-<u>Acknowledgement:</u>

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