FLSmidth Denmark

Vigerslev Alle 77
DK-2500 Valby
Copenhagen. Denmark

Windimurra Vanadium
Australia

Special Roasting kiln
Ø4.75 x 102 m

Unax Cooler
9 x Ø2.1 x 16 m

Period of Inspection: 26/10-07/11 2013

Kiln Audit

Windimurra
Vanadium Roaster
Australia

Clients Specialist…………………………Mr. Todd Richardson
Clients Specialist…………………………Mr. Rick Wingo

FLS Specialist......................... Mr. Niels Peter Jensen

Participants at final meeting held in Perth:

Michael Minosora	Managing Director	
Daniel Harris	Chief Operating Officer	
Ian Campbell	Area Manager	FLSmidth
Niels Peter Jensen	Senior Engineer	FLSmidth

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Introduction:

A visit was paid to the plant in the period 26/10 – 07/11 – 2013.

The main purpose of the visit by FLSmidth Minerals was to view the kiln installation with the aim to increase performance and study the present operation, and based on the findings; provide comments and recommendations for actions needed to improve the kiln performance.

The kiln was originally designed for a nominal production of 2400 MTPD at a kiln speed of 0.9 rpm. With a max speed of 1.0 rpm

At a later stage the client intends to increase this kiln production to app. 3050 MTPD as per 2008 design by Proteus Engineering.

The kiln itself has not been modified, and is for the time being usually running at a production of 1800 MTPD.

The product temperature is usually lower than 150 °C.

Conclusion

Kiln Burner

The problem with the present kiln operation is the bad burner performance and the likewise bad performance of the kiln feed hood.

In order to get a better burner performance, the existing burner has to be upgraded at least to its former design. The repair job done on the burner is helping, but it is not enough.
The best solution is to install a new Uniflow burner with the capacity to handle the later planned increase in production.

A further solution is to install a Duo flex burner in the kiln. This burner will allow a much greater possibility for making adjustments to the flame formation in the kiln.

Kiln Feed hood

The kiln feed end hood is of a different construction than what was originally installed in the kiln.

To overcome the problem with a constant leak of material from the feed hood, the entire hood has to be replaced with a new feed hood, looking more like what was originally installed, in which dust dropping out of the airflow is led directly to the kiln.
Note, a new feed hood will not prevent back spillage from the kiln due to ring formations or overfilling.

The feed screw is to be inserted at least 0.5 m further in to the kiln.
By changing the feed hood it seems that this will be possible without changing the length of the feed screw.

Unax kiln:

The kiln speed has to be in accordance with the set point given in the control room.

To improve kiln performance it is recommended to install a dam ring in the kiln outlet.

Installing ceramic lifters in the transition zone will further improve the kiln performance.

Production & Operation

At my visit to the plant the kiln was producing app.1800 TPD as targeted, but many stops and back spillage constantly reduced the output.

The quality of the kiln output varies heavily over the day.

The actual kiln speed did not correspond with the speed recorded in the control room. Set point: 100 % only gave 0.61 rpm on the kiln.

There is a constant spillage of material from the kiln inlet. A spillage of app. 7 % of the product are normal for this type of feed hood, but the tendency to ring formation at the kiln inlet is often increasing the spillage to such a degree, that the kiln has to be stopped for cleaning.

Normally there are three main reasons for rings in the kiln inlet:

1) Wet and sticky feeding to the kiln
2) Poor burner performance.
3) Chemical components in the feed

Here it mainly looks like a mix between a poor burner performance and a chemical reaction is taking place.

Also the unstable kiln operation contributes to the risk of rings forming in the kiln inlet.

It is important to keep a constant relation between kiln speed and feed.

%	tpd	tph	rpm	Fuel, Nm3/hr
30	720	30.0	0.27	1166
40	960	40.0	0.36	1460
45	1080	45.0	0.40	1595
50	1200	50.0	0.45	1723
55	1320	55.0	0.50	1844
60	1440	60.0	0.54	1961
65	1560	65.0	0.59	2074
70	1680	70.0	0.63	2184
75	1800	75.0	0.68	2293
80	1920	80.0	0.72	2401
85	2040	85.0	0.77	2510
90	2160	90.0	0.81	2620
95	2280	95.0	0.86	2733
98	2352	98.0	0.88	2803
100	2400	100.0	0.90	2850

Fuel consumption includes rough adjustment for increased heat loss at reduced production

The gas consumption is not an exact figure but varies with feed moisture and kiln radiation.

Uniflow Burner:

The Uniflow burner was taken out of the kiln for a closer investigation:

This investigation showed that two big holes had been cut in the primary air nozzle.

It seems this was done to allow two new flame scanners, placed in the back of the burner, to see the flame through the burner primary air channel.

These big cut-outs destroyed the primary air nozzle completely, and it was not possible to obtain a good flame shape from the burner due to an uneven distribution of primary air.

The flame was burning up and along the top of the kiln.

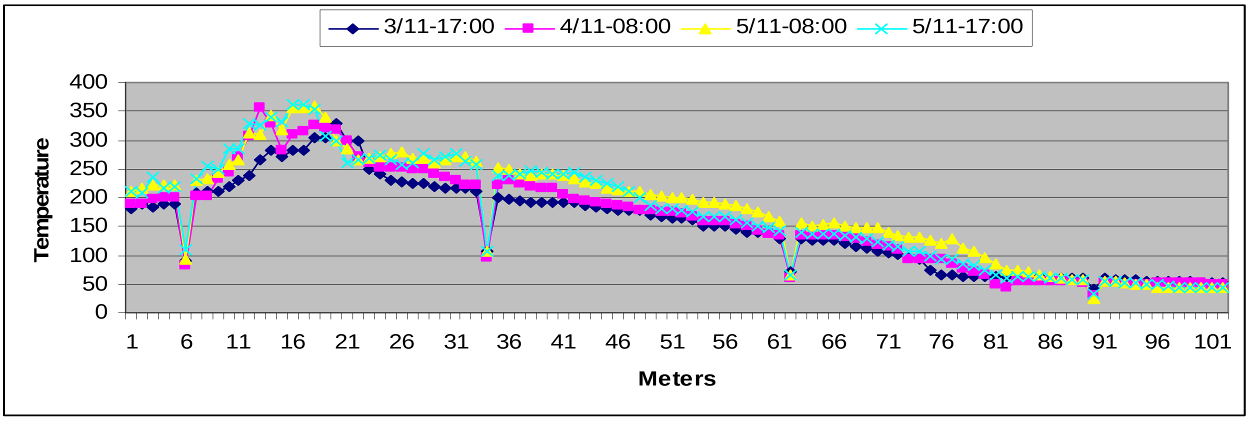
To get a good flame from the Uniflow Burner it requires an air velocity at app. 80 – 100 m/sec in the nozzle. At the same time the amount of primary air has to be 10 – 15 % of L_{min}.

This will give the needed flame momentum from the burner.

To overcome some of this problem the two big cuts was partly closed and the burner was reinstalled into the kiln.

Over the next couple of days the flow and pressure of primary air was measured, to hereby find the best settings for the speed of the primary air fan.

Between the 3/11 and the 5/11-13 a series of temperature measurements was carried out on the kiln shell operating at app. 80 t/h



See also enclosed chart for primary air:

WINDIMURRA KILN I

Primary air. Measuring 30-10-2013

Burner adjustment		Nozzle	opening:	15.0	mm	Fan motor speed:	Varied	RPM
			Scale:	15	mm	Fan impeller:	832	mm
Burner type:	Uniflow	OG-3000				Fan type:	ABB LV-K PP	

Measuring	Primary air tube		D=	0.394	m	Area			0.12186	m2
	Elevation			100	m	Air pressure			970	mbar
	Axial nozzle D=	0.203	m	d=	0.180	m	A=	0.0069151	m2	
	Area increase due to 15 mm opening							0.0022	m2	
	Area increase duct outs						A=	0.0142	m2	
								0.0233		
Design parameters:	Production			2400	t/24h					
	Heat consumption			253	kcal/kg					

									max2935
RPM		1050	1200	1350	1500	1650	1800	1950	2100
RPM %	28.2	35	40	45	50	55	60	65	70
Pd mbar	0.06	0.08	0.11	0.14	0.18	0.23	0.29	0.38	0.50
Ps mbar	1.82	2.54	3.55	4.60	5.70	7.90	9.68	12.2	15.50
Pt mbar	1.90	2.62	3.66	4.75	5.92	8.15	10.05	12.95	16.25
Temp. C	34.3	40.0	30.8	34.0	36.1	38.2	37.2	38.7	33.1
Rt. kg/m3	1.1053	1.0859	1.1200	1.1095	1.1032	1.0982	1.1038	1.1013	1.1252
V air tube =	3.3	3.8	4.4	5.0	5.7	6.5	7.2	8.3	9.4
Lmin. kg/h	35673	35673	35673	35673	35673	35673	35673	35673	35673
Q kg/h	1597	1828	2177	2445	2764	3117	3509	4013	4653
Q Nm3/h	1235	1414	1684	1891	2138	2411	2714	3103	3598
V nozzle =	17.2	20.1	23.2	26.3	29.9	33.8	37.9	43.4	49.3
% Primary.	3.5	4.0	4.7	5.3	6.0	6.8	7.6	8.7	10.1
Impulse	60	80	109	139	179	229	288	378	497

As shown here it is not possible to obtain the right value for primary air due to the fact that the burner nozzle is partly destroyed.

As the burner is today, it is recommended to operate the primary air fan at 75 % speed. Giving some 11 % primary air, but at a very low speed.

The old Uniflow burner is equipped with a lance of 10 m. That means the burner position in the kiln can be adjusted over a span of normally 2.0 m. In extreme cases this adjustment can be made up to 5.0 m. if this is needed.

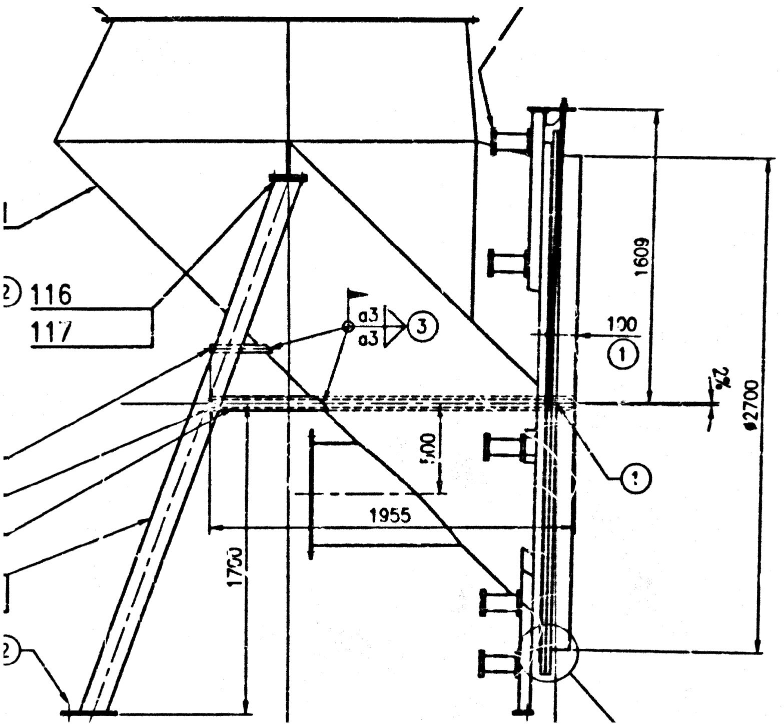
At present time there is a switch sitting at the burner rail. This switch only allows the burner to be located in one position.

Kiln feed hood:

The kiln feed hood is equipped with a dust hopper underneath. This hopper is constantly receiving dust from the kiln. Under a normal kiln operation some 7 % of the production is leaving the kiln as dust. Some of that dust is falling out of the kiln off gases in the feed hood. The rest of the dust is going to be separated in the de-dusting cyclones and after that it returns to the paddle mixer and kiln feed screw.

The dust falling in to the hopper is ending on the ground, where it has to be manually removed. All FLS kiln seals today comes with the hopper and a dust return system sized to the dust loss.

The originally installed kiln feed end was constructed in such a way that dust automatic returned to the kiln with no need for a feed hopper. This would still not prevent back spillage from overfilling the kiln as experienced here.



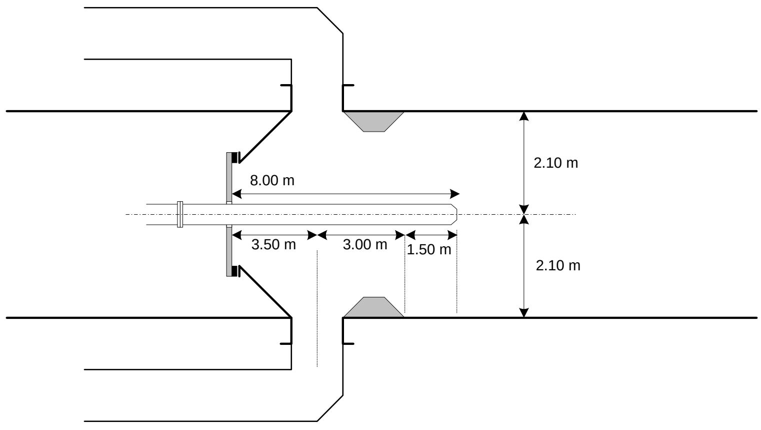
The hot return dust from the cyclones is going to the paddle mixer, where it meets up with the soda ash and new wet kiln feed. This is creating a mix with a tendency to form an extremely hard material that can affect the feed screw.

If a new kiln feed end is installed, I will suggest that the return dust is led directly to the kiln, not going to the mixer.

Kiln roasting in general:

During normal operation there are substantial fluctuations in the quality of the product leaving the kiln.

A dam ring installed before the Unax outlet can reduce this fluctuation.
A dam ring will keep the material a longer time in the hot zone.



The height of the dam ring is to be considered at a later time, but normally app. 0.35 to 0.45 m over the kiln lining as the original refractory drawing shows.

For further improvement of the heat transfer in the kiln it is possible to install ceramic lifters in the transition zone. This will increase the preheating of the material, and decrease the tendency to “slide” on the kiln lining. It will only add minor loads to the kiln drive.

Kiln Speed/feed:

To obtain the best overall kiln performance it is important to keep the same degree of filling in the kiln. This means that the kiln speed has to be locked directly to a specific tonnage of feed.