INDUSTRIAL EXPERIENCE WITH TOPSOE SULFURIC ACID CATALYST - VK38AX

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Haldor Topsoe A/S is a Danish Corporation headquarted some 10 miles north of Copenhagen with subsidiaries in France, Japan, Turkey and United States. The company was founded in 1940 by Dr. Topsoe who today is the company's Chairman and Chief Executive Officer. Corporate administration as well as most of the company's Research, Development and Engineering activities are handled at the headquarters in Copenhagen.

Catalysts are manufactured in a plant located approximately 20 miles from the headquarters as well as in facilities owned and operated by the company's subsidiary in the United States near Houston in Texas.

Already when the company was very young, it paid attention to sulfuric acid catalyst and as early as 1948, important research work was published through the Danish Academy of Science.

The sulfuric acid catalyst, which is designated VK-catalyst, was industrially introduced in the late 60's. The originally introduced types were manufactured by tabletizing but since 1976, the VK38AX catalyst has been available as extrudates.

This catalyst combines high activity with high mechanical strength and it has been well received on the American market.

VK38AX is available in conventional cylinder form as well as in ring-shape. The manufacturing program of VK38AX catalyst is the following:

6 mm VK38AX extrusions
10 mm VK38AX rings
20 mm VK38AX rings

ACTIVITY

The high activity of the VK38AX catalyst has been demonstrated in several cases. It is not uncommon that a switch from other brands of catalyst to VK38AX gives the user an advantage of lowering the inlet temperature to catalytic passes and in a 4-pass sulfur burning, single absorption plant, improvement in conversion would typically be from 98.3% up to 98.7% when VK38AX is used.

Conversion efficiency of 99.0% in a sulfur burning, single absorption plant has also been reported.

In sulfur burning double absorption plants, this feature is not of such importance although an improvement can normally be expected here by switching to VK38AX catalyst. Also, the possibility of operating at very low O_2/SO_2 ratio gives improved efficiency of plant performance.

10 mm VK38AX Rings

The advantage obtained by installing VK38AX 10 mm VK38AX rings compared to conventional shape is a reduction in pressure drop across the catalyst passes. Due to the higher void volume of the 10 mm VK38AX ring-shaped catalyst, the pressure drop will be reduced by 45% by replacing 6 mm extrusions with 10 mm ring-shaped catalyst. However, to compensate for the higher void, the catalyst volume of 10 mm VK38AX rings has to be increased by 18% - compared to 6 mm VK38AX extrusions - to obtain the same activity level and the effect will thus be a pressure drop corresponding to about two-thirds of the pressure drop of 6 mm VK38AX extrusions.

This feature is of interest for plants which need to increase production capacity or which are tight in blower capacity. Also plants operated with electrical driven blowers will profit by operating with loadings of 10 mm VK38AX rings.

20 mm VK38AX Rings

The 20 mm VK38AX rings are intended to be placed as a protection layer on top of a pass suffering rapid pressure drop rise and hereby increasing the tolerance for foreign dust entering the pass with the feed flow. By placing a layer of 20 mm VK38AX rings on top of a pass, the pressure drop build-up across the pass will take place much slower resulting in longer periods of operation between screenings.

Industrial experience with 20 mm VK38AX rings indicate that the period of uninterrupted operation can be prolonged considerably.

This effect was the first time demonstrated in a metallurgical plant in Belgium. With conventional shaped catalyst, this plant operated 16 months having a pressure drop development from 3-24" WG. The following run, where ring-shaped VK38AX catalyst was placed on top of the same pass, the pressure drop development was from 3-3½" WG during 18 months of operation. The dust contamination lay-down on the pass during these two runs were almost identical.

In the following, some plants operating with VK38AX as partial or entire loading shall be discussed:

APPENDIX I gives figures of performance of a first pass operating with ring shaped VK38AX catalyst. The mentioned plant is located in Texas. Source of SO_2 is combined sulfur burning and decomposition of spent acid. Plant design is 4-pass single absorption. This plant first introduced 20 mm VK38AX rings as a protection layer on the existing first pass. The pressure drop development prior to this installation would typically be from 10" WG to 50" WG during 6 months of operation. When operating with a protection layer of 20 mm VK38AX rings on top of this pass, the pressure drop development during 7 months of operation was 10" to 25" WG.

In August 1979, the first pass was changed into 10 mm VK38AX rings and again the protection layer was installed on top of this major catalyst loading. As it will be seen, 10 months of operation resulted in a pressure drop development from 4" to 11" WG.

This plant is restricted as to cool down the gas going to the first pass due to limitation in the boiler. The lowest possible inlet temperature to the first pass is the actual shown, 806°F.

This customer reported a steam saving corresponding to 2000 lbs.steam/hr due to the installation of the ring-shaped catalyst. Since same location is steam short, the money value of this saving was reported to be $80,000. during 10 months of operation.

A similar experience of improvement of performance due to installation of VK38AX is seen in the enclosed APPENDIX II. Besides the impressive lower inlet temperature to the first pass, it is interesting to note the increase of production rate. Two times this plant made a record production rate of 850 STPD during its 15 months of operation.

The development in pressure drop across the first pass was, as it is seen, dampened considerably compared to previous performance.

This plant is located in Virginia and has at a later date installed 10 mm VK38AX rings in the lower passes. Being a 3-pass system with air dilution before the last pass, the overall efficiency is not impressive when having an inlet concentration of SO_2 to the first pass of 12.7%. However, the installation of VK38AX meant an increase in overall conversion from 94-96.6%.

APPENDIX III gives figures of catalyst loading and performance of a plant operating with VK38AX catalyst in all passes. This plant is located in north western Canada.

Although high in catalyst loading, it is impressive to note the overall conversion of 98.9% in this single absorption design.

The figures of performance in APPENDIX IV comes from a plant located in northwestern United States. This plant had a hot gas filter, and as one will notice, ring type VK38AX was used as a filter element as well as the first pass loading.

Like many other plants in the phosphate fertilizer industry, this location is steam short and had to produce extra steam. With a gas contract of 4.60 $/MMBTU, the plant people calculated the internal value of 1000 lbs steam to be $7. In view of this, it is interesting to note the reported steam saving of 3500-4000 lbs/hr due to installation of ring-shape VK38AX catalyst.

The final example, APPENDIX V, comes from a plant in Florida. Pressure drop development during 1 year of operation was reported to be from 4" to 6½" WG across the first pass. The reported steam saving was said to be in the range of 10-12,000 lbs/hr.

This location generates power to be used at the plant. Furthermore, excess power is sold to local power plants. The credit this location received was $93,000. during the first year of operation with VK38AX ring-shaped catalyst in the first pass.

These examples demonstrate the versatility of Topsoe VK38AX sulfuric acid catalyst.

As a final remark, it should be mentioned that a new production line for manufacturing VK38AX will be completed in May 1981. Besides manufacturing equipment, this line will include a fully equipped, modern laboratory where testing of new as well as spent V_2O_5 catalyst will be made.

The location of this facility is Pasadena, Texas which means that from mid 1981, VK38AX will be a domestic produced catalyst.

APPENDIX I

PERFORMANCE OF A FIRST PASS OPERATING WITH VK38AX RING-SHAPED CATALYST

	AUGUST 1979	JUNE 1980
Production rate	770 STPD	770 STPD
SO_2 %	8.6	9.0
O_2 %	10.9	10.6
CO_2 %	2.6	2.5
N_2 %	77.9	77.9
Catalyst loading-liters		
- 20 mm VK38AX rings	5,700	
- 10 mm VK38AX rings	21,900	
Inlet temperature °F	806	806
Outlet temperature °F	1110	1116
Pressure drop		
- inches WG	4	11

This client reported a steam saving of 2000 lbs/hr compared to previous operation with conventionally shaped catalyst.

Moneywise, this meant a saving of $80,000.

APPENDIX II

PERFORMANCE OF A FIRST PASS OPERATING WITH A LOADING OF TOPSOE

SULFURIC ACID RING-SHAPED CATALYST

PREVIOUS PERFORMANCE		PRESENT PERFORMANCE				
		JULY 1979	NOVEMBER 1979	APRIL 1980	JULY 1980	OCTOBER 1980
PRODUCTION RATE	750 STPD	762 STPD	790 STPD	800 STPD	810 STPD	792 STPD
SO_2%	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%
O_2%	8.25%	8.25%	8.25%	8.25%	8.25%	8.25%
CATALYST LOADING	27,000 liters	3,200 liters of 20 mm VK38AX rings 29,500 liters of 10 mm VK38AX rings				
INLET TEMP. °F	845	807	795	800	800	795
OUTLET TEMP. °F	1168	1162	1150	1156	1158	1155
PRESSURE DROP " WG						
- CLEAN CATALYST FIGURES	14½" WG	7.8" WG	10.0" WG	15.8" WG	19.6" WG	27.8" WG
- AFTER 8 MONTHS OF OPERATION	55" WG					

APPENDIX III

PERFORMANCE OF A PLANT OPERATING WITH VK38AX CATALYST IN ALL PASSES

Production Rate : 425 STPD

Gas Composition : 8.8% SO_2 + 12.15% O_2

Conversion : 98.9%

PASS NO.	1	2	3	4
Inlet temperature °F	790	818	800	780
Outlet temperature °F	1102	937	822	786
Catalyst loading, liters				
- 20 mm VK38AX rings	3400			
- 10 mm VK38AX rings	13800	11,500	28,000	43,000
- 6 mm VK38AX rings		8,000		
Pressure Drop " WG	7	7	5	5

The catalyst lay-out of this plant is designed for 99.0% conversion at a production rate of 375 STPD and 8.0% SO_2 inlet first pass.

APPENDIX IV

PERFORMANCE OF A FIRST PASS OPERATING WITH VK38AX RING-SHAPED CATALYST

	JUNE 1980		MARCH 1981
Production rate	1050 STPD		1082 STPD
SO_2%	11.5		11.4
O_2%	9.45		9.55
HOT GAS FILTER-Catalyst Loading			
- 20 mm VK38AX rings		3,300	
- 10 mm VK38AX rings		6,700	
Inlet temperature °F	757		770
Outlet temperature °F	?		?
Pressure Drop " WG	3½		7
FIRST PASS-Catalyst Loading			
- 20 mm VK38AX rings		5,500	
- 10 mm VK38AX rings		38,000	
Inlet temperature °F	767		778
Outlet temperature °F	1109		1116
Pressure Drop " WG	3		3½

This client reported a steam saving in the range of 3500-4000 lbs/hr compared to previous operation with conventionally shaped catalyst.

APPENDIX V

PERFORMANCE OF A FIRST PASS

OPERATING WITH A LOADING OF TOPSOE SULFURIC ACID RINGSHAPED CATALYST

	FEB 1980	JULY 1980	FEB 1981
Production rate	1818 STPD	1750 STPD	1672 STPD
SO_2%	11.2	11.4	10.4
O_2%	9.75	9.55	10.55
Catalyst loading-liters			
- 20 mm VK38AX rings		7,920	
- 10 mm VK38AX rings		46,450	
Inlet temperature °F	766	770	773
Outlet temperature °F	1132	1130	1130
Pressure Drop - inches WG	4	4½	6½

This client reported a steam saving in the range of 10-12,000 lbs/hr compared to previous operation with conventionally shaped catalyst.