SULFURIC ACID CATALYST

STATE OF THE ART

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Abstract

After a presentation of what the sulfuric acid industry should expect from a catalyst supplier, this paper will deal with examples of energy savings obtainable when using "state of the art" sulfuric acid catalysts.

Figures for energy savings obtained by typical sulfur burning acid plants using Topsoe sulfuric acid catalyst, VK38AX will be presented.

Introduction

Through the years a lot of changes have appeared in the Sulfuric Acid Industry. Processes have changed, plants have become larger, economy has become tighter, and environmental demands have grown.

In order to keep pace with these developments, new construction materials and new construction concepts have been developed, all with the aim of making the economics of sulfuric acid production as attractive as possible under the circumstances given. When looking at the history of the sulfuric acid industry, and any other industry for that matter, one will note that the growth of new ideas has been fertilized mainly by rocketing energy prices. Consequently, one will find that the inovations now being implemented in sulfuric acid plants are less than 10 years old.

The Role of the Catalyst Supplier

One exception to the above is the concept of the ring-shaped sulfuric acid catalyst. Topsoe first introduced the ring-shaped sulfuric acid catalyst in 1969 and later in 1977 VK38AX was first marketed in the U.S. VK38AX exemplifies Topsoe's commitment to progress in catalysis.

We believe that one of the most important qualities your catalyst supplier should have is the ability to foster new ideas and develop these sufficiently for commercial application.

Ring-shaped sulfuric acid catalyst contributes as much to energy conservation as many of the other developments. When taking into consideration that the pressure drop of the catalyst mass is responsible for 1/4 of the total sulfuric acid plant pressure drop, and the fact that the same volume of VK38AX 10 mm rings will have only 50% of the pressure drop of conventional catalysts, one realizes that it is possible to save about 1/8 of the total plant pressure drop just by installing VK38AX rings.

Naturally, a catalyst manufacturer who really does his homework and analyzes the feedback from industrial operation will play a major role in the future development of the industry. As you all know, the American Sulfuric Acid Industry has responded in the best way possible: By adopting the idea of ring-shaped VK38AX catalyst. Typical data for the VK38AX catalysts are shown in Table 1.

Quite apart from the catalyst itself it is, of course, expected that a catalyst supplier can provide related information and services. Catalyst testing, recommendations with respect to catalyst loadings and/or catalyst changeout together with performance evaluations are such services normally available. Catalyst recommendations made in connection with an increase in production is a natural service for a catalyst supplier too. Our Catalyst division gives support, not only to the end users of Topsoe catalyst but works together with our engineering division, Research and Development division as well as with other engineering companies .

In this connection it is interesting to note that by changing from conventional catalyst to VK38AX 10 mm rings it is possible to increase production by approximately 10% without consuming more energy.

The reason for such a relatively high increase in production can be found in part in Fig. 1, which shows the pressure drop versus gas velocity for VK38AX catalysts at clean gas conditions; and secondly, when changing to ring-shaped VK38AX catalysts it is generally possible to increase the SO_2 concentration by about 0.5% absolute.

When considering the overall cost of revamping a sulfuric acid plant, one may find a catalyst changeout attractive.

As can be seen from Fig. 2, which is an example from an American single absorption, sulfur burning plant, the energy savings can be substantial.

The plant in question was able to operate for a period of only 8 months before having to shut down due to pressure drop limitations.

After installation of VK38AX rings the same plant operated for 15 months before taking a turnaround for routine maintenance. Pressure drop was not limiting as can be seen in the figure.

For the sake of good order, one should add that the conditions were the same during both operating periods and that the production was a little higher when operating with VK38AX rings.

We have not received figures for the actual energy savings achieved but the shaded area is a graphical expression of this. Actual savings may be related to more than just pressure drop. Furthermore, the plant avoided the cost of an additional shutdown.

Consider as an example a 550 STPD (500 MTPD) single absorption sulfur burning plant with indirect cooling as outlined in Table 2. Taking into account the feed gas contains 8% SO_2, the clean catalyst pressure drop is 32" WG (800 mm WG) and the overall conversion is 98%.

By replacing regular shaped catalyst with the same volume of VK38AX 10 mm rings, the figures in column 2 are obtained. It can be seen that there is a subtantial benefit in both the possibility of increasing the overall conversion from 98% to 98.5% and in the lower pressure drop. A total saving in excess of $77,000 per year is obtained solely by replacing the conventional catalyst loading with VK38AX 10 mm rings.

Some more examples of the superior performance of VK38AX catalysts are found in Reference 1 which is available from Haldor Topsoe, Inc. upon request.

Tomorrows Sulfuric Acid Catalyst

The preceeding was a brief resume on where we are today - The state-of-the-art - in sulfuric acid catalysts. The concept of using ring-shaped catalyst for the production of sulfuric acid is an unqualified success. This is proven not only by the industry's acceptance but also by the fact that our competitors in this field are also offering ring-shaped catalysts as part of their product slate. Meanwhile, as our colleagues in engineering development divisions create new ideas, so do the catalyst engineers. They aim constantly to improve sulfuric acid catalyst and to achieve, for example, the goals given in Table 3. This shows a sulfuric acid catalyst giving an even lower initial pressure drop and rate of pressure drop build-up, in addition to a lower attrition loss and the same or even higher activity than VK38AX 10 mm rings!

These objectives have occupied us for some time and we have now developed what we call the "D" type which we hope will be the sulfuric acid catalyst of tomorrow.

In Fig. 3 we have added the pressure drop curve for the D type catalyst. It shows a pressure drop in the order of 80% of the pressure drop of VK38AX 10 mm rings and indicates a catalyst with pressure drop characteristics which we consider good. It is important to remember that low pressure drop is not an aim in itself because in order to avoid channeling, any pass of sulfuric acid catalyst should have a pressure drop of at least 3-4 inches. Thus, if catalysts with unbalanced low pressure drop characteristics were loaded into sulfuric acid converters, one could fear that the bed height would have to be increased in order to reach 3-4 inches of pressure drop. Such a situation, of course, be less favorable both from a technical and an economical standpoint.

The ring-type catalyst concept gives lower pressure drop and better dust tolerance which, as stated, has been proven industrially all around the world. The D catalyst concept is basically the same as for the ring-type catalyst only it offers even more advantages.

The higher void fraction of a catalyst bed loaded with D catalyst will not only reduce the catalyst pressure drop but will further increase the dust tolerance.

Data for our new D catalyst is given in Table 4 together with specifications for the VK38AX of today. Please note that the pressure drop characteristics of the D catalyst are improved compared to the VK38AX 10 mm rings, whereas the high mechanical strength of the VK38AX 10 mm ring is maintained.

The D catalyst is now suitable for commercial application and pilot tests indicate that the total plant pressure drop savings when installing the D catalyst will be in the order of 15.5% as compared to the previously stated and industrially proven total plant pressure drop savings of 12.5% when changing to VK38AX 10 mm rings.

Table 5 compares the energy savings obtainable when utilizing VK38AX 10 mm rings and D catalyst in a 1600 STPD monohydrate double absorption sulfur burning plant.

As can be seen, the savings resulting from a change to VK38AX 10 mm rings or D catalyst are substantial. These savings are based on an estimated average pressure drop advantage during an operating period of one year and one might add they are rather conservative.

We would like to offer the D catalyst to you, the sulfuric acid industry. Anyone familiar with the difficulties encountered in extruded catalyst production will admire the shape and appearance of the D catalyst, which by the way is called Daisy.

We believe that Daisy is a great "New" catalyst and are confident that you will share our enthusiasm about Daisy when it becomes commercially available later this year.

Reference:

"Industrial Experience With Topsoe Sulfuric Acid Catalyst - VK38AX" by Mr. Allan Albjerg. (Presented at AIChE Joint Meeting, 1981).

TABLE 1

VK38AX Catalyst Data

Shape	Cylinder	Ring	Ring
Diameter, mm	6	10	20
Relative pressure drop	2	1	0.5
Relative attrition loss	0.5-1	1	2-3

TABLE 2

550 STPD sulfur burning, single absorption plant replacing present catalyst loading with VK38AX 10 mm rings on a volume basis.

	Conventional Catalyst	VK38AX 10 mm rings
Production, STPD	550	550
Conversion, %	98	98.5
Pressure drop, inches WG	32	16
Savings in energy per year, kWh	-	850,000
Savings in Sulfur per year, t	-	315
Savings in $ per year	-	77,150.00

Basis: $.05/kWh, $110./t of Sulfur, 70% blower efficiency, 8300 hours on stream per year.

TABLE 3

Data for Desired Sulfuric Acid Catalyst

Diameter	Unknown
Shape	Better
Relative Attrition loss	Better
Relative Pressure drop	Better

TABLE 4

VK38AX Catalyst Data

Shape	Cylinder	Ring	D	Ring
Diameter, mm	6	10	8-13	20
Relative pressure drop	2	1	.80	.5
Relative attrition loss	0.5-1	1	1	1.5-2

Table 5

1600 STPD Sulfur Burning DA/DC Plant

Catalyst	Conventional	VK38AX 10 mm	D
Clean Catalyst Pressure Drop, inches WG	18	9	7.2
Estimated Average Pressure Drop Saving inches WG	-	12	15.5
Annual Saving, kWh	-	1,400,000	1,800,000
Annual Saving, $	-	70,000.00	90,000.00

Basis: 10.5% SO_2, 99.7% conversion, same catalyst volume, blower efficiency 0.7. Energy price $.05/kWh.

Figure 1.

Clean Catalyst Pressure Drop

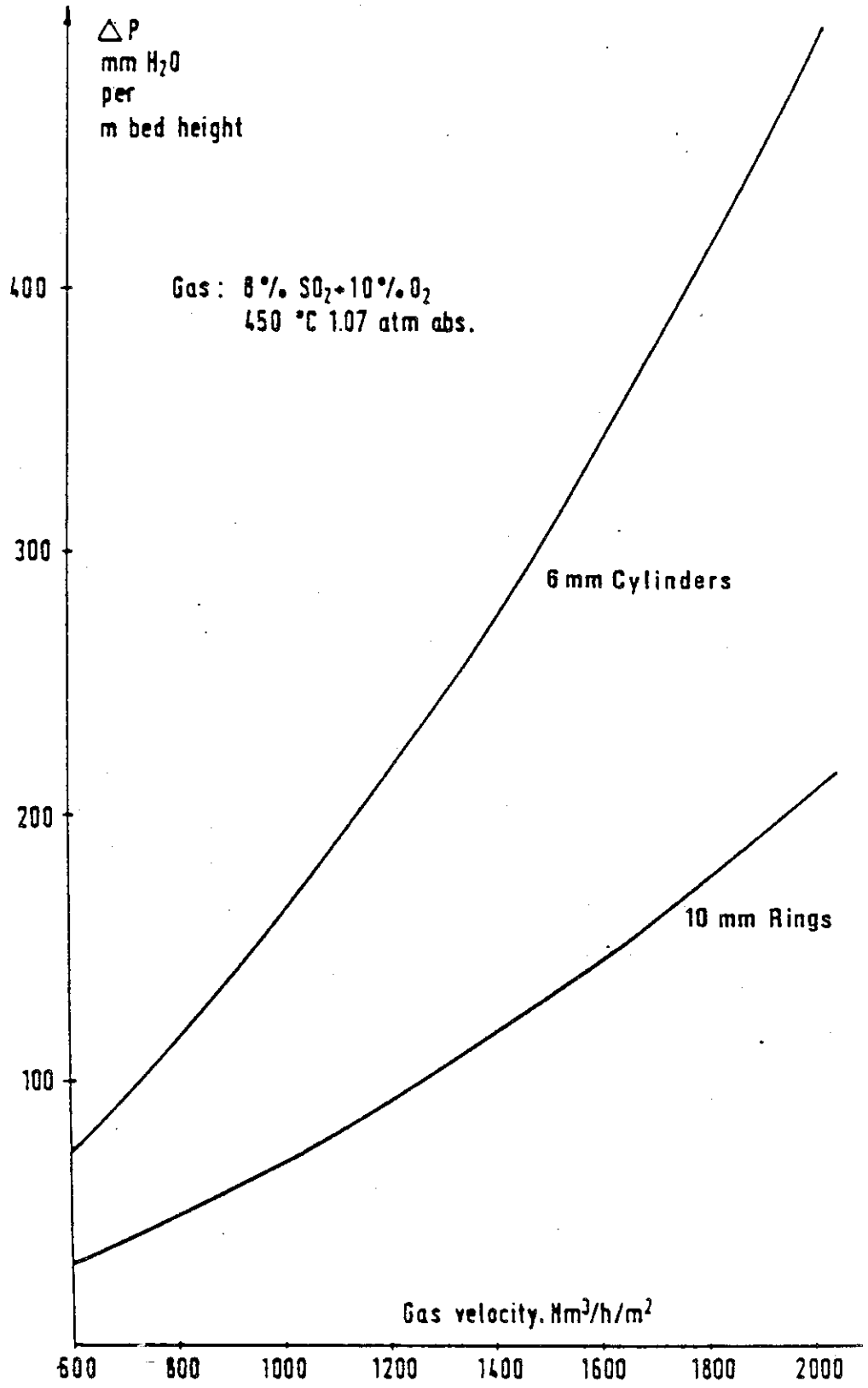

Figure 2.

Experienced Pressure Drop Development

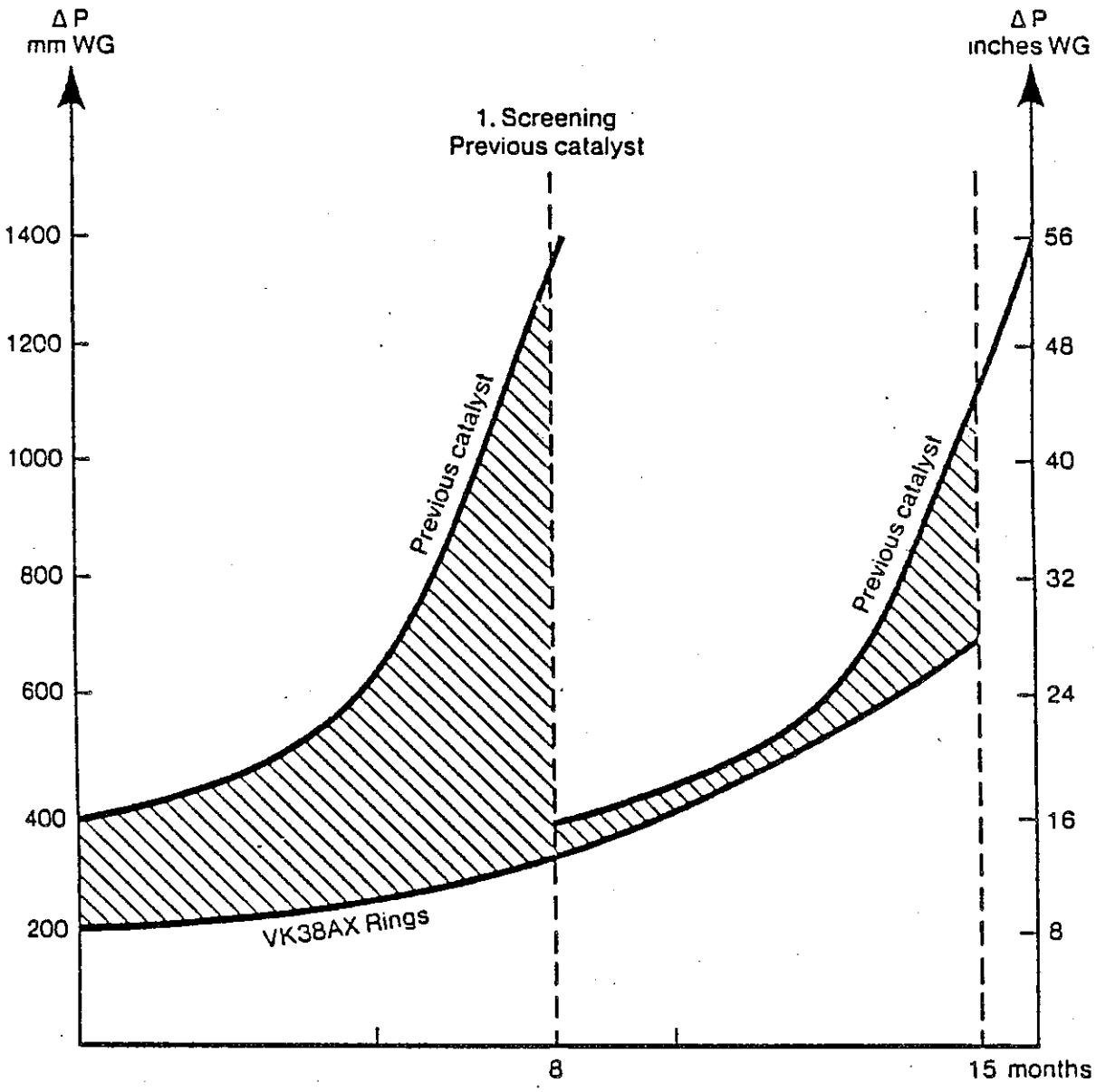

Figure 3.

Clean Catalyst Pressure Drop