青岛千呈矿产有限公司

QINGDAO QIANCHENG MINERALS CO., LTD.

YOUFANGTAIZI VILLAGE (HETOUYUAN

INDUSTRY ZONE), JIAOZHOU, QINGDAO, CHINA

Technical Data

- Certificate of Analysis

Vanadium Catalysts for Sulfuric Acid Producing

Medium-Temperature Series QH101

PHYSICAL PROPERTIES & CHEMICAL PROPERTIES	Models under Medium-Temperature Series QH101		
	QH101	QH101-2H	QH101-2HY
Shape	Cylindrical	Ring-Shaped	Plum-Shaped
Color	Yellow or Reddish-Brown	Yellow or Reddish-Brown	Yellow or Reddish-Brown
Diameter (mm)	Φ4.5-5.5	Φ9.5±0.5/3.5±0.5	Φ10.0±0.5/3.5±0.5
Length (mm)	5-15	5-15	5-15
Bulk Density (Kg/L)	0.51-0.53	0.49-0.51	0.48-0.50
Vanadium Pentoxide (V_2O_5)	≥7.5%	≥7.5%	≥7.5%
Activity (SO_2 Conversion rate at 485°C)	≥81%	≥86%	≥86%
Compressive Strength	≥70 N/cm	≥40 N/cm	≥40 N/cm
Attrition Rate	≤5.0%	≤5.0%	≤5.0%

Features & Application:

The Series catalysts are available in cylindrical, ring-shaped, and petal-shaped forms. They are produced using refined high-performance carriers made from Northeast China's premium diatomite. Combined with the company's proprietary production technology, these catalysts demonstrate the following key features: • Uniform distribution of active components • Low ignition temperature • High thermal stability (operating temperature up to 650°C) • High conversion rate and compressive strength • Low pulverization rate, minimal resistance, and extended lifespan • Broad application range

QHS101 series is primarily used in the contact process for sulfuric acid production, where SO2 is oxidized to SO3. The ring-shaped and petal-shaped variants are especially suitable for smelting gas desulfurization processes under suboptimal purification conditions. Product Standards: HG/T2086-2013

Personal Precautions:

Avoid breathing dust

Wear respirator when airborne dust is present

Harmful by Inhalation

Danger of serious damage to health by prolonged exposure

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Vanadium Catalysts for Sulfuric Acid Production

Low-Temperature Series QH108

PHYSICAL PROPERTIES & CHEMICAL PROPERTIES	Models under Medium-Temperature Series QHS101#		
	QH108	**QH108-1H**	**QH108-1HY**
Shape	Cylindrical	Ring-Shaped	Plum-Shaped
Color	Yellow or Reddish-Brown	Yellow or Reddish-Brown	Yellow or Reddish-Brown
Diameter (mm)	Φ4.5-5.5	Φ9.5±0.5/3.5±0.5	Φ10.0±0.5/3.5±0.5
Length (mm)	5-15	5-15	5-15
Bulk Density (Kg/L)	0.51-0.53	0.49-0.51	0.48-0.50
Vanadium Pentoxide (V_2O_5, %)	≥6.2	≥6.3	≥6.3
Activity (SO_2 Conversion rate at 410°C)	≥35%	≥42%	≥42%
Compressive Strength	≥60 N/cm	≥40 N/cm	≥40 N/cm
Attrition Rate	≤5.0%	≤5.0%	≤5.0%

Features & Application:

The Series catalysts, available in cylindrical, ring-shaped, and petal-shaped forms, are made from refined diatomite carriers. They offer excellent performance at low temperatures, with features such as:

• Low ignition temperature. • Superior activity at lower operating temperatures. • High resistance to pulverization.

• Extended operational lifespan.

Primarily used in the sulfuric acid industry and for the oxidation of SO2 into SO3 during the production of sulfonation products. When combined with the S101 medium-temperature series, it reduces the inlet temperature of the converter, shortens startup time, saves energy, improves overall conversion efficiency, reduces emissions, and increases production.

Personal Precautions:

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Vanadium Catalysts for Sulfuric Acid Production

QHTY Series High-Efficiency Vanadium Catalysts QHTY-201

PHYSICAL PROPERTIES & CHEMICAL PROPERTIES	Models under Medium-Temperature Series QHS101#		
	QHTY201	QHTY201-2H	QHTY201-2HY
Shape	Cylindrical	Ring-Shaped	Plum-Shaped
Color	Yellow →Reddish-Brown, Green	Yellow →Reddish-Brown, Green	Yellow →Reddish-Brown, Green
Diameter (mm), Φ	4.5-5.5	10.0/4.0	10.5/4.0
Length (mm)	5-15	5-15	5-15
Bulk Density (Kg/L)	0.48-0.50	0.44-0.46	0.43-0.45
Vanadium Pentoxide (V_2O_5, %)	≥7.5	≥7.5	≥7.5
Activity (SO_2 Conversion rate at 485°C)	≥81%	≥86%	≥86%
Ignition Temperature	370 °C	370 °C	370 °C
Compressive Strength	≥70 N/cm	≥40 N/cm	≥40 N/cm
Attrition Rate	≤5.0%	≤5.0%	≤5.0%

Features & Application: Suitable for all types of raw materials and sulfuric acid producing processes, operating within 400-620 °C. Through extensive production practices, the company has developed the series high efficiency vanadium catalysts using unique production formulas, advanced optimized processes, and high-quality diatomite from its own mines as the carrier. These high efficiency catalysts exhibit greater stability and reliability. Key features include: • Wide operational temperature range. • Enhanced thermal stability and activity. • Strong resistance to pulverization and mechanical degradation. • Extended operational lifecycle. The QHTY series is suitable for a variety of raw materials, large-scale sulfuric acid production units, and different processes, meeting increasingly stringent environmental requirements for SO2 emissions. It ensures stable and long-term operation of production facilities, achieving overall performance comparable to leading international products. QHTY201 Medium-Temperature Series Features: high-efficiency catalysts offer higher activity with lower loading volume. Thanks to their unique formula and high-quality diatomite carrier, these catalysts feature: • Significantly increased specific surface area and porosity. • Excellent structural integrity and enhanced activity. • Reduced loading requirements, leading to lower energy consumption. • Extended operational lifespan, enabling long-term continuous production and ensuring compliance with emission standards. The special design of QHTY201 catalysts allows them to endure the harsh conditions in the first and second stages of the converter. They exhibit strong resistance to impurities, resulting in lower pressure drop during operation.

Personal Precautions:

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Vanadium Catalysts for Sulfuric Acid Production

QHTY Series High-Efficiency Vanadium Catalysts QHTY208

PHYSICAL PROPERTIES & CHEMICAL PROPERTIES	Models under Medium-Temperature Series QHS101#		
	QHTY208	**QHTY208-1H**	**QHTY208-1HY**
Shape	Cylindrical	Ring-Shaped	Plum-Shaped
Color	Yellow →Reddish-Brown, Green	Yellow →Reddish-Brown, Green	Yellow →Reddish-Brown, Green
Diameter (mm), Φ	4.5-5.5	10.0/4.0	10.0/4.0
Length (mm)	5-15	5-15	5-15
Bulk Density (Kg/L)	0.51-0.53	0.49-0.51	0.48-0.50
Vanadium Pentoxide (V_2O_5, %)	≥6.2	≥6.2	≥6.2
Activity (SO_2 Conversion rate at 410°C)	≥35%	≥42%	≥42%
Ignition Temperature	360 °C	360 °C	360 °C
Compressive Strength	≥60 N/cm	≥40 N/cm	≥40 N/cm
Attrition Rate	≤5.0%	≤5.0%	≤5.0%

Features & Application:

Idea use for various raw materials and processes, with an operating range of 390-550 °C.

(2) QHTY208 Low-Temperature Series Features: The QHTY208 Series high-efficiency catalysts maintain excellent activity under low temperatures, high SO_2, and low O_2 conditions. Compared to most similar catalysts, its performance is significantly improved, making it particularly suitable for use in the third, fourth, and fifth stages of converters.After the first absorption stage, the catalyst demonstrates even better performance under conditions of low SO_2 and higher O_2 concentrations. Thanks to its special formula and manufacturing process, the TY208 Series offers:

• Higher activity during long-term operation. • A well-balanced resolution between catalyst activity and resistance to pulverization.

• Significantly lower screening loss.

Personal Precautions:

Avoid breathing dust

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Cesium Catalyst Series QHCS308

PHYSICAL PROPERTIES & CHEMICAL PROPERTIES	Models under Medium-Temperature Series QHS101#	
	QHCS308-1H	**QHCS308-1HY**
Shape	Ring-Shaped	Plum-Shaped
Color	Yellow →Reddish-Brown, Green	Yellow →Reddish-Brown, Green
Diameter (mm), Φ	10.5/4.0	10.5/4.0
Length (mm)	5-15	5-15
Bulk Density (Kg/L)	0.44-0.46	0.43-0.45
Vanadium Pentoxide (V_2O_5, %)	≥6.0	≥6.0
Cesium Oxide (Cs_2O), %	≥5.0	≥5.0
Activity (SO_2 Conversion rate at 390°C)	≥30%	≥30%
Activity (SO_2 Conversion rate at 410°C)	≥48%	≥48%
Compressive Strength	≥40 N/cm	≥40 N/cm
Ignition Temperature	350 °C	350 °C
Attrition Rate	≤5.0%	≤5.0%

Features & Application:The upper-middle sections of the first stage of single conversion systems. The first and second stages of dual conversion systems. The operational temperature range is 380°C to 550°C. (3) CS308 Cesium Catalyst Series
Features:The CS308 Series catalysts, also known as cesium-based catalysts, use V_2O_5 as the active component and alkali metal cesium as an auxiliary active component. Utilizing premium refined diatomite from the company's proprietary mines as the carrier, these catalysts are produced using a unique manufacturing process and optimized active formula. Key characteristics include:
• High activity across a wide temperature range, from low to high temperatures. • Reduced startup time. • Lower energy consumption. • Significant reduction in SO_2 emissions. • Dual advantages of low ignition temperature and high thermal resistance, making them suitable for use in any stage of the converter.

Personal Precautions:

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Application Technology for Catalysts

1. Application Technology for Catalysts

1) Catalyst Loading

To ensure optimal performance of the catalysts, the following guidelines must be adhered to during the loading process:

1.1 Inspection Before Loading

• Check the converter's louver plates for flatness and integrity. Ensure appropriate gaps between plates.

• Inspect the refractory lining, walls, and partition plates for cracks or air leakage. Address any issues before proceeding.

1.2 Sieving

• During transport, minor powder generation (<3–5%) may occur due to vibration or collisions. This powder increases bed resistance and may block heat exchangers or pipelines.

• Use a sieve to remove the powder before loading.

1.3 Marking and Uniform Loading

• Mark catalyst loading heights on the inner walls and pillars of the converter based on the required loading volume for each stage.

• Ensure a level catalyst bed with uniform height to prevent gas flow deviations.

1.4 Weather Precautions

• Vanadium catalysts are highly hygroscopic, and moisture can reduce both activity and strength.

• Avoid loading during rainy conditions. For cloudy weather, prepare waterproof tents for protection.

1.5 Loading Procedure

• Begin loading from the inner side of the converter, moving toward the manhole.

• Avoid direct contact with catalysts by workers; use wooden boards to distribute weight.

• After loading, level the bed surface according to the marked heights. Remove all tools and debris, ensuring no foreign objects are left in the catalyst bed.

1.6 Moisture Protection

• Once loading is complete, immediately seal the manhole to prevent moisture exposure.

• If the startup process cannot begin immediately, isolate and seal the converter from the system to avoid air ingress and moisture contamination.

1.7 Personal Safety

• Catalyst powder can irritate skin and respiratory systems. Workers must wear protective gear, including hats, masks, and gloves, minimizing skin exposure.

2) Heating, Startup, and Shutdown
2.1 Heating Procedure
• Use preheated, dry air ($H_2O \leq 0.10$ g/Nm³) as the heating medium. Avoid direct use of diesel or coal combustion gases due to high moisture content ($H_2O = 20–30$ g/Nm³), which may condense on the catalyst surface and degrade its performance.
2.2 Heating Rate
• Heat the catalyst at a controlled rate of 30–50°C/hour.
• For systems fully loaded with medium-temperature vanadium catalysts, allow SO2 gas introduction when the first-stage inlet temperature reaches 410–420°C and the last-stage outlet temperature exceeds 180°C.
• If low-temperature vanadium catalysts are loaded in the upper sections of the first stage, SO2 gas may be introduced when the first-stage inlet temperature reaches 370–380°C.
2.3 Initial SO2 Gas Introduction
• During the initial startup, limit SO2 concentration to approximately 3% to avoid excessive heat generation from adsorption, surface reactions, and sulfate formation.
• Gradually increase SO2 concentration once the catalyst bed temperature stabilizes and stops rising abruptly. Maintain the first-stage outlet temperature below 600°C.
2.4 Temporary Shutdown•
• For temporary shutdowns, increase operating temperature by 10–15°C several hours before shutdown.
• If the first-stage inlet temperature remains above 360°C during the shutdown period, low-temperature vanadium catalysts may allow direct SO2 gas introduction during restart
2.5 Long-Term Shutdown
• During prolonged shutdowns, purge the system with dry air at 400–420°C to remove residual SO2 and SO3.
• Ensure proper venting; the stack should emit no white smoke, and the SO2 concentration at the outlet of the last stage should be below 0.03% before cooling the system.
3) Normal Operation
3.1 Operating Temperature
• Medium-temperature vanadium catalysts operate effectively within 420–600°C. Avoid prolonged operation above 600–620°C to prevent thermal degradation and activity loss.
3.2 Activity Adjustment
• Over time, catalyst activity may decline. Gradually increase the inlet operating temperature by no more than 5°C per year to maintain conversion efficiency.
• If the first-stage activity declines but overall conversion remains within specifications, defer temperature adjustments to extend catalyst lifespan.
4) Effects of Harmful Impurities
4.1 Arsenic Compounds
In SO_2 gas, arsenic compounds are primarily present as As_2O_3, which impacts the catalyst in two distinct ways:
4.1.1 Adsorption and Oxidation
When As_2O_3 enters the converter, it is adsorbed by the catalyst carrier and oxidized to

As_2O_5. The reaction is as follows:
Reaction:
$As_2O_3 + O_2 \rightarrow As_2O_5$
The resulting As_2O_5 covers the catalyst surface and clogs the micropores, leading to reduced catalyst activity, lower conversion efficiency, and increased resistance. This type of poisoning generally occurs at temperatures below 550°C.

4.1.2 Volatilization and Reaction

At temperatures above 550°C, As_2O_3 reacts with the active component V_2O_5, forming volatile arsenic-vanadium compounds, which gradually deplete the V_2O_5 content of the catalyst and cause it to lose activity. The following reaction occurs:
Reaction:
$As_2O_3 + O_2 + V_2O_5 \rightarrow V_2O_5 \cdot As_2O_5$
The $V_2O_5 \cdot As_2O_5$ compound volatilizes and condenses on the surface of catalysts in downstream converter stages, forming a black crust. This crust reduces catalyst activity, causes agglomeration, and increases resistance within the bed.

4.2 Fluorine Compounds

Fluorine in SO_2 gas mainly exists as HF. When HF coexists with water vapor and SiO_2, the
following reaction occurs:
Reaction 1:
$4HF + SiO_2 \rightarrow SiF_4 + 2H_2O$
This reaction indicates that fluorine compounds in the gas exist in two forms: HF and SiF_4, both of which adversely affect the catalyst:

4.2.1 Destruction of Catalyst Carrier

HF reacts with the catalyst carrier to produce SiF_4, causing pulverization of the catalyst, reduced activity, and increased resistance.

4.2.2 Formation of Silica Coating

The SiF_4 produced in Reaction 1 reacts further with water vapor as follows:
Reaction 2:
$SiF_4 + 2H_2O \rightarrow 4HF + SiO_2$
The SiO_2 generated in this reaction forms a white silica crust on the catalyst surface, blocking micropores and further reducing catalyst activity.

4.3 Mineral Dust

Mineral dust in the furnace gas mainly consists of gangue and Fe_2O_3. At industrial operating temperatures, the active components of the catalyst are in a molten state. Dust particles adhere to the liquid film on the catalyst surface, causing accumulation. The effects are as follows:
• Dust accumulation reduces the active surface area of the catalyst.
• It increases resistance within the catalyst bed.
• Dust can enter the micropores of the catalyst, causing mechanical blockages.
• Fe_2O_3 in the dust reacts with condensed sulfuric acid at the micropore openings, forming iron sulfate ($Fe_2(SO_4)_3$). This reaction causes crusting on the catalyst surface, particle agglomeration, increased resistance, and decreased activity.

4.4 Moisture

Water vapor at temperatures above 400°C does not harm the catalyst. However, the catalyst is highly hygroscopic at lower temperatures, leading to:

• Condensation of water vapor in the catalyst's micropores due to capillary action, even at higher temperatures.
• Dissolution of $K_2S_2O_7$, K_2SO_4, and V_2O_5, which migrate to the catalyst surface and cause particle agglomeration.
• Changes in the potassium-to-vanadium ratio, reducing catalyst activity.
• Increased operating temperatures and accelerated thermal degradation.

4.5 Acid Mist (Sulfuric Acid Vapor)

Acid mist, often containing Fe_2O_3, forms around dust particles in the furnace gas. The effects are as follows:
• When acid mist contacts the catalyst at 400°C, free sulfuric acid (or sulfurous acid) evaporates and decomposes.
• Sulfates in the mist adhere to the catalyst surface, forming solid deposits known as catalyst crusting.
• These deposits react with pyrosulfates to form low-melting-point adhesive compounds that bond with other dust particles, blocking pores and reducing catalyst activity.
• Resistance within the bed increases, further compromising performance.

4.6 Impurity Control Standards

To minimize the effects of impurities, the concentrations of harmful substances should be controlled as follows (measured at the main blower outlet):

Impurity	Concentration Limit
Acid Mist	≤ 0.03 g/Nm³ (after primary demisting)
	≤ 0.005 g/Nm³ (after secondary demisting)
Moisture	≤ 0.10 g/Nm³
Dust	≤ 0.005 g/Nm³ (dry purification)
	≤ 0.002 g/Nm³ (wet purification)
Arsenic	≤ 0.001 g/Nm³
Fluorine	≤ 0.001 g/Nm³

5) Notes

5.1 Disposal of Used Catalysts

• The old catalyst that cannot be used anymore, as well as the fine powder sieved during loading, contains toxic substances and must be carefully handled.
• Arsenic-contaminated old catalysts should never be discarded casually. Exposure to rain or water infiltration can release As_2O_3 and other toxic substances into water sources, contaminating drinking water.

5.2 Storage of Unused Catalysts

• If operations are suspended and vanadium catalysts are unloaded, they should be stored in plastic bags to prevent moisture absorption.
• Catalysts from different stages of the converter should be stored separately to avoid mixing.

6) Transportation and Storage of Catalysts

6.1 Packaging and Handling

- Catalysts should be packed in plastic bags and sealed in iron drums.
- During transportation, avoid impact or rolling of the packaging drums to prevent catalyst breakage.

6.2 Protection from Moisture

- During transportation and storage, protect the catalysts from moisture and contamination by other chemicals, as these may degrade their performance and mechanical strength.

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