



# AN OVERVIEW OF WAX HYDROFINING CATALYSTS IN CHINA

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Catalytic properties of FV series and RFW-3 wax hydrofining catalysts have been introduced and compared. Effects of different catalysts such as FV-10, FV-30, RJW-2 and RJW-3 on the quality of wax at a pilot plant have been also discussed. FV-30's life has been also tested at a large-scale plant. The experimental results show that RJW-3 have high catalytic performance and wax products obtained meet the requirement of Chinese wax standard.

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## Introduction

Wax during the oil refinery process is one of the important chemical products.<sup>1</sup> Wax plays an important role in *Chinese* industries such as lighting, packaging, farming, chemicals, rubber, medicine and homecare products, etc. *China* is No. 1 in production and consumption of wax in the world. The production and consumption of wax in *China* has reached to a tune of 16 and 7.81 million tons respectively in 2011.<sup>2</sup> Although *China* has a lot of wax, it still imports special wax products from other countries due to the high quality performance. Sinopec *Fushun* Research Institute of Petroleum and Petrochemicals have developed new hydrofining catalysts for petroleum wax such as FV series wax hydrofining catalysts such as FV-1, FV-10, FV-20 and FV-30 have large pore volume, high specific surface area and concentrated pore structure which are suitable to wax hydrofining. They have good activity, selectivity and stability, high mechanical strength, especially highly condensed aromatics saturation activity. Catalysts have good repetition characteristics. Successful commercial application of FV series catalysts is used under medium pressure, low temperature and low H<sub>2</sub>-to-wax ratio conditions. Wax hydrofining process can produce petroleum wax products which meet requirements for the national standard of wax (food grade) (GB7189-94).<sup>3</sup> RJW-3 wax hydrofining catalysts have been applied on a 100,000 t/y Wax Hydrofining Plant of Jingmen Petrochemical Company. It is a tri-lobe shape for wax hydrofining catalysts with Ni-W as its active component. RJW-3 wax hydrofining catalysts have high activity for aromatic hydrogenation, anti-cracking ability, proper pore structure, small diffusion resistance and improving mass transfer in gas-liquid dispersions of a reactor.<sup>4</sup>

In the present paper, catalytic properties of FV series and RFW-3 wax hydrofining catalysts have been reviewed. Effects of different catalysts such as FV-10, FV-30, RJW-2 and RJW-3 on the quality of wax at a pilot plant have been also introduced, in comparison to product quality and performance of FV and RJW series wax hydrofining catalysts. FV-30's life has been also studied at a large-scale plant.

## Discussion

### Comparing catalytic properties between FV series and RJW-3 wax hydrofining catalysts

Table 1 shows catalytic properties of FV series and RFW-3 wax hydrofining catalysts.<sup>4,5</sup> FV series and RFW-3 wax hydrofining catalysts consisted of Ni element. Furthermore, FV-20, FV-30 and RJW-3 had the same components (Mo-Ni). On the other hand, FV-1 and FV-10 only included W element. The catalysts had different shapes except FV-20 and FV-30. FV-10 and FV-20 almost have the same performance such as diameter, pore volume, surface area, porosity and mechanical strength. In addition, FV-1 and FV-30 have the similar properties such as diameter, pore volume, surface area and mechanical strength.

### Effects of different catalysts such as FV-10, FV-30, RJW-2 and RJW-3 on the quality of wax at a pilot plant

Zhang Yanxia<sup>3</sup> introduced a new catalyst (FV-30). She described how to produce FV-30 and studied effects of different catalysts (FV-10 and FV-30) on the quality of wax in Table 2. The experimental results showed that FV-10 and FV-30 had the same performance except easy absorbance, however easy absorbance of FV-30 is very close to that of FV-10.

On the other hand, wax products met the requirement of *Chinese* wax standard except needle penetration when FV-10 and FV-30 as catalysts were used. FV-30 had good catalytic performance, high strength, small particular and more adaptable to wax feedstock. Its shape was five tooth balls.

Liu Yuqing<sup>4</sup> studies on catalytic properties of RJW-2 and RJW-3. Table 3 showed effects of different catalysts (RJW-2 and RJW-3) on the quality of wax at a pilot plant. The experimental results showed that RJW-2 and RJW-3 had the same performance except readily carbonizable substances and UV absorbance of condensed-nuclei aromatics. When RJW-2 was used as a catalyst, readily carbonizable substances of wax products did not meet *Chinese* food grade wax standard. RJW-3 had the high catalytic activity, high performance for aromatics saturation, anti-cracking ability and high compressive strength.

**Table 1.** Properties of FV series wax hydrofining catalysts and RFW-3 hydrofining catalysts.

Quality parameters	Catalysts				
	FV-1	FV-10	FV-20	FV-30	RJW-3
Active metal components	W-Ni	W-Mo-Ni	Mo-Ni	Mo-Ni	Mo-Ni
Catalysts' shape	Five tooth balls /sphere	Sphere	Cloverleaf pattern	Cloverleaf pattern	Butterfly
Diameter (mm)	2.2-2.6	1.1-1.5	1.1-1.2	2.0-2.4	1.6
Pore volume, (mL·g <sup>-1</sup> )	≥0.40	≥0.35	≥0.34	≥0.42	≥0.22
Surface area, (m <sup>2</sup> ·g <sup>-1</sup> )	≥150	≥150	≥150	≥160	≥110
Bulk density, (g·cm <sup>-3</sup> )	0.90-0.95	0.82-0.88	0.74-0.81	0.70-0.76	0.97
Porosity (%)	35	44	42	45	-
Mechanical strength (N·mm <sup>-1</sup> )	≥30 (N/grain)	≥18	≥16	≥30 (N/grain)	≥18

**Table 2.** Effects of different catalysts (FV-10 and FV-30) on the quality of wax at a pilot plant

Quality parameters	FV-10	FV-30	#58 semi-refined wax standard	FV-10	FV-30	#64 fully refined wax standard
Feedstock	No.1	No.1		No.2	No.2	
Temperature (°C)	260	260		260	260	
Pressure (MPa)	6.0	6.0		6.0	6.0	
Volume hour space velocity (h <sup>-1</sup> )	1.1	1.1		1.0	1.0	
H <sub>2</sub> -to-wax ratio	300	300		500	500	
Saybolt colour (number)	+30	+30	≥+17	+30	+30	≥+25
Light stability (number)	5-6	5-6	≤7	3	3	≤5
Thermal stability (number)	+15	+15		+25	+25	
Melting point (°C)	58.90	58.90	58-60	65.8	65.8	64-66
Weight of oil (%)	1.10	1.10	≤1.80	0.30	0.30	≤0.50
Needle penetration, 25°C (0.1mm)	28	28	≤20	17	17	≤16
Easy absorbance (cm <sup>-1</sup> )						
280 nm	0.466	0.473		0.102	0.106	
290 nm	0.242	0.244		0.510	0.502	

**Table 3.** Effects of different catalysts (RJW-2 and RJW-3) on the quality of wax at a pilot plant

Quality parameters	RJW-2		RJW-3		Food grade wax standard
	Feedstock	Product	Feedstock	Product	
Temperature (°C)	243		235		
Hydrogen pressure (Mpa)	6.50		5.70		
Weight hour space velocity (h <sup>-1</sup> )	14		16		
Colorimetry colour (number)			7		
Saybolt colour (number)	+16	+30		+30	≥25
Melting point (°C)	63.6	63.6	60.7	60.8	
Mechanical impurities	No	No	Yes	No	No
Water	No	No	No	No	No
Light stability (number)	6	3	6	3	≤5
Weight of oil (%)	0.36	0.38	0.45	0.48	≤0.50
Readily carbonizable substances	Fail	Fail	Fail	Pass	Pass
UV absorbance of condensed-nuclei aromatics (cm <sup>-1</sup> )					
280-289nm	0.09	0.011	0.20	0.11	≤0.15
290-299nm	0.16	0.006	0.24	0.076	≤0.12
300-359nm	0.19	0.001	0.31	0.052	≤0.08
360-400nm	0.01	0.001	0.03	0.004	≤0.02

**FV-30's life tests at a large scale plant**

Wang Shixin<sup>5</sup> explained more details about FV-30's life tests at a large scale plant. Table 4 showed results of FV-30's life tests at a large scale plant. The experimental results showed that FV-

30 kept the same catalytic performance such as light stability, thermal stability, Saybolt colour and readily carbonizable substances after 2505 hours. However, products' easy absorbance and UV absorbance of condensed-nuclei aromatics did not follow any rules.

**Table 4.** Results of catalyst life tests at a large-scale plant

Quality parameters	201 h	449 h	1217 h	1593 h	2025 h	2505 h
Light stability (number)	3	3	3	3	3	3
Thermal stability (number)	+29	+29	+28	+28	+28	+28
Saybolt colour (number)	+30	+30	+30	+30	+30	+30
Readily carbonizable substances	Pass	Pass	Pass	Pass	Pass	Pass
Easy absorbance (cm <sup>-1</sup> )						
280nm	0.024	0.013	0.022	0.026	0.023	0.013
290nm	0.015	0.006	0.011	0.016	0.012	0.007
UV absorbance of condensed-nuclei aromatics (cm <sup>-1</sup> )	Pass	-	Pass	-	Pass	Pass
280-289nm	0.013		0.013		0.048	0.009
290-299nm	0.009		0.009		0.036	0.007
300-359nm	0.004		0.003		0.012	0.005
360-400nm	0.001		0		0.001	0

**Conclusion**

Based on the above review and discussion, RJW-3 used to refine wax products is better than that of FV-30. RJW-3 has the high catalytic activity, high performance for aromatics saturation, anti-cracking ability and high compressive strength. Wax products obtained meet Chinese food grade wax standard. On the other hand, although FV-30 has a lot of advantages such as it has good catalytic performance, high strength, small particular and more adaptable to wax feedstock, wax products' needle penetration does not meet the requirement of *Chinese* wax standard, so RJW is one of the best catalysts for refining wax products.

**References**

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