

Self adaptive real-time optimization of 2 # Fluid Catalytic Cracking Unit (FCCU) in a Jiangsu refinery

The 2 # FCCU of a petrochemical company in Jiangsu Province is a high-low parallel riser catalytic cracking unit designed to process hydrogenated residual oil with a designed processing capacity of 2 million tons per year (8400 hours of annual operation). The unit was put into operation in July 2014. In order to further improve the economic efficiency of the unit and tap into its potential, dynamic correlation integration adaptive real-time optimization technology has been introduced to perform online optimization operations on the unit.

The real-time optimization control system has 5 optimization schemes and 8 optimization variables. It can automatically optimize the key operating variables of the riser reactor online according to the selected optimization scheme. The system was first put into operation in January 2016 and runs smoothly. Through data comparison and analysis, the total liquid yield and economic benefits have been improved, and the optimization effect is significant. From October 15th to 20th, 2016, the factory conducted a formal technical assessment of the optimization system.

Optimize variables, constraints, and control schemes:

Optimization objectives: Five optimization objectives, namely the maximal the yields for three single products, that are liquid hydrocarbons, gasoline, and diesel yields as the main products, and the optimization scheme for the overall economic benefit of the unit, including the total liquid yield.

Optimization variables: There are a total of 8 variables, namely: riser outlet temperature, pre lift steam flow rate, pre lift dry gas flow rate, feed atomization steam flow rate, feed preheating temperature, terminating agent flow rate, recycle oil flow rate, and new catalyst addition amount.

Technical Assessment

Price table in the assessment:

Raw	Unit price (RMB/ton)	Products	Unit price (RMB/ton)
Hydrogenated residue	3776.02	Dry gas	4337.00
New catalyst	20945.00	LPG	5575.22
		Gasoline	6124.07
		Diesel	5497.58
Others	150.00	Slurry	1962.35

The assessment results (Benefit scheme)

	Manual operation	Real time optimization	Increment of optimization
Dry gas yield(%)	5.28	5.37	0.09
LPG yield (%)	14.32	14.84	0.52
Gasoline yield (%)	46.45	47.10	0.65
Diesel yield (%)	21.97	21.17	-0.80

Slurry yield (%)	4.39	4.13	-0.26
Total liquid yield (%)	82.73	83.11	0.38
Total economic benefit(RMB/ton raw)	1212.72	1234.53	22.81 (about 3.2\$/Ton raw)

Comparison results of long term optimization (Gasoline scheme)

	Manual operation (18days)	Real time optimization (128 days)	Increment of optimization
Dry gas yield(%)	5.18	4.99	-0.19
LPG yield (%)	15.91	14.68	-1.23
Gasoline yield (%)	45.30	46.60	1.30
Diesel yield (%)	19.52	19.64	0.12
Slurry yield (%)	5.47	4.73	-0.74
Total economic benefit(RMB/ton raw)	1404.58	1426.04	21.46 (about 3.01\$/Ton raw)