ACE TECHNOLOGY: PRECISION AND RELEVANCE

SUMMARY

ACE Technology® Model R, R+, and Model P cracking units provide unprecedented precision and relevance for laboratory-scale research of the FCC process. The combination of high precision and relevant results makes ACE Technology® systems potent research tools for catalyst selection and development, feedstock qualification, understanding existing commercial performance, commercial FCC design, and kinetic modeling.

PRECISION AND RELEVANCE

Important parameters for evaluating laboratory cracking methods include precision, relevance, versatility, and productivity. Each of these must meet expectations for a particular lab unit to be viable as a tool for making decisions that impact the profitability of commercial scale operations. Versatility and productivity are discussed in the ACE Technology brochure. Precision and relevance are discussed below.

Excellent precision provides the necessary resolution to qualify and rank various catalysts and feedstocks. The precision of data from ACE units reduces the number of runs required for making decisions and also virtually eliminates the need for costly duplicate runs. High precision makes it possible to perform studies requiring tight-operation of the unit (e.g., catalyst strippability).

Relevance to commercial cracking is similar to accuracy in that the laboratory results are directly related to commercial performance. A relevant test provides cracking results for a feed and catalyst from a particular unit which are systematically related to the commercial yields. Many lab-scale FCC tests are precise but not relevant. Some tests are relevant but not very precise.

THE ACE TECHNOLOGY® METHOD

ACE Technology® provides unprecedented precision and relevance on a lab-scale. The high precision is related to the carefully designed feed injection system, reactor, and product collection system. The relevance is derived from the proprietary reactor design which emulates commercial FCC performance and can be easily tuned or calibrated to improve the correlation to a specific operation.

TYPICAL DATA

Precision

Repeated runs in the ACE-Model R at 990°F (532°C) and 5.0 catalyst-to-oil ratio are summarized in Tables 3. The properties of both the catalyst and feed used in the cracking runs are provided in Tables 1 and 2. The relative error values indicate the Model R and associated analytical equipment are very precise. The relative error is nominally 2% or less for each yield.

TABLE 1
CATALYST PROPERTIES

Catalyst	ECAT
Total SA, m^2/gm	213
Zeolitic SA, m^2/gm	142
Matrix SA, m^2/gm	71
Z/M	2.0
RE_2O_3, wt%	2.4
UCS	24.34
Nickel, ppmw	1400
Vanadium, ppmw	2500

TABLE 2
FEED PROPERTIES

Feedstock		Feed A
API Gravity		21.2
Specific Gravity, 60/60°F		0.927
Sulfur, wt%		0.87
Conradson Carbon Residue, wt%		0.8
Distillation (D 2887)	wt%	°F/°C
	10	659 / 348
	50	833 / 445
	90	983 / 528

To obtain the full precision benefits of ACE Technology it is important to use stable and accurate analytical equipment. The results of Table 3 are derived from integration of the Model R with appropriate analytical tools.

KAYSER
TECHNOLOGY

ACE TECHNOLOGY: PRECISION AND RELEVANCE

TABLE 3
RESULTS FROM REPEAT RUNS AT 5 C/O

CRACKING DATA SUMMARY					STATISTICAL SUMMARY		
Run No.	42	46	65	69	MEAN	STD.	REL. ERR.
Date	11/8/96	11/8/96	11/26/96	11/26/96	VALUE	DEV.	(%)
Recovery, wt%	99.2	99.5	98.4	99.3	99.1	0.5	0.5
Cat-to-Oil, wt/wt	5.00	5.00	5.00	5.00	5.00	---	---
430°F+ Conv., wt%	72.96	72.93	73.01	72.67	72.89	0.15	0.2
YIELDS, wt%:							
Coke	5.48	5.45	5.60	5.45	5.49	0.08	1.4
Dry Gas	3.11	3.13	3.08	3.07	3.10	0.03	0.9
Hydrogen	0.10	0.11	0.09	0.10	0.10	0.01	5.5
H_2S	0.46	0.46	0.46	0.46	0.46	0.00	0.0
Methane	1.11	1.11	1.08	1.06	1.09	0.03	2.4
Ethane	0.69	0.69	0.70	0.70	0.69	0.00	0.4
Ethylene	0.76	0.76	0.75	0.76	0.75	0.01	0.8
Propane	1.59	1.50	1.60	1.52	1.55	0.05	3.2
Propylene	4.51	4.43	4.44	4.38	4.44	0.05	1.1
n-Butane	1.29	1.24	1.31	1.25	1.27	0.04	2.8
Isobutane	4.65	4.43	4.71	4.48	4.57	0.13	2.9
C4 Olefins	4.76	4.83	4.67	4.72	4.75	0.07	1.4
1-Butene	1.08	1.08	1.07	1.06	1.07	0.01	0.9
Isobutylene	1.07	1.11	1.05	1.07	1.08	0.02	2.2
c-2-Butene	1.12	1.13	1.10	1.11	1.12	0.02	1.5
t-2-Butene	1.44	1.47	1.42	1.43	1.44	0.02	1.5
Butadiene	0.05	0.04	0.04	0.05	0.05	0.004	7.7
Gasoline	47.57	47.92	47.59	47.81	47.72	0.17	0.4
LCO	17.43	17.45	17.49	17.51	17.47	0.04	0.2
650°F+	9.61	9.62	9.50	9.81	9.64	0.13	1.3
TOTAL	100.00	100.00	100.00	100.00			

Relevance

The performance of the ACE-Model R is compared to two distinct commercial operations in Table 4. Both commercial units are modern, but CASE 1 is for a fully modernized, short contact time unit which is operating well (with radial feed nozzles, good riser termination, and good stripper design).

The operation of the Model R involved tuning the operation until the laboratory C/O was within about 10% of the commercial C/O (at the commercial level of conversion). The data are for a cracking temperature (initial fluid-bed) set at riser outlet temperature.

For CASE 1, the ACE unit performs within 10% of the reported commercial yields except C4 saturates. These offsets are simple to tune or further calibrate for as discussed below. **Overall, this case shows ACE Technology is able to provide data very close to commercial operation for modern FCC units.**

Both C4 saturates and olefins may be better approximated by operating the ACE unit at a higher initial temperature than the commercial riser outlet temperature. If the initial cracking temperature is set closer to an average riser temperature (about 20°F higher than riser outlet), then at constant conversion the C4 saturates yield decreases, C4 olefins yield increases, and the coke yield decreases. These shifts would provide an even closer comparison for CASE 1.

TABLE 4
COMPARISON OF ACE-MODEL R
TO COMMERCIAL DATA
AT CONSTANT CONVERSION

	FCC CASE 1	FCC CASE 2
Parameter	**ACE/Commercial Ratio**	**ACE/Commercial Ratio**
Cat/Oil	0.88	1.13
Coke	1.08	1.17
Dry Gas	1.05	0.60
LPG	1.07	0.94
Propane	1.04	0.72
Propylene	1.08	0.93
C4 Saturates	1.25	1.20
C4 Olefins	0.92	0.86
Gasoline	0.96	1.03
LCO	0.96	1.02
Bottoms (650°F+)	1.04	0.96
C3 Saturation	0.97	0.82
C4 Saturation	1.17	1.24

For CASE 2, the commercial operation is experiencing more thermal cracking as evidenced by higher dry gas and propane yields (lower ratios above). In addition, the C4s exhibit a similar trend to CASE 1 which is primarily attributable to the selected temperature for the laboratory cracking. The major yields are well predicted by the ACE unit including gasoline, distillate, and bottoms.

CASE 2 provides an example of using a laboratory unit as a benchmark for determining if a particular unit is performing properly. It is apparent that a review of the commercial unit would uncover a source for the thermal cracking which may then be addressed. After repair, the thermal cracking response of the commercial unit would move closer to the data obtained directly from the ACE unit.