Guest Forum

Request from the Laboratory in an Oil Refinery to Testing and Analyzing Equipment Manufacturers

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Oil refineries are always required, as social duties, to strictly ensure "safety" and appropriately manage "environment, health and quality" and "stable supply" and, as economic duties, to seek and manage "productivity." The mission of the laboratory of the oil refinery is to support good management, and it is essential for the laboratory to select and manage appropriate testing and analyzing equipments in order to fulfill the mission. This article explains from what viewpoints the laboratories select testing and analyzing equipments and contains some of my own experience. Since a typical laboratory owns quite a large variety of testing and analyzing equipments, the "sulphur analyzer (total sulphur content)" is taken up as an example for the purpose of this article.

Introduction

At oil refineries[*1], as crude oil[*2] is run through the refining equipments, various kinds of petroleum products are manufactured and blended and then shipped, as shown in Figure 1. Reducing sulphur concentrations in fuel oil and oil products is one of the important efforts to reduce environmental loads[*3]. A typical oil refinery conducts testing and analysis in the production and blending processes according to the following procedures in order to obtain low-sulphur fuel oil and oil products:

- Production process

  The production processes are generally controlled by the sulphur regulation value for environmental management, the sulphur specification value for quality control and the operating procedures for operation management of refining equipments. Samples of crude oil and from each production process (on-site) are put to testing and analysis in the laboratory, and the measured sulphur concentrations are clarified. The test results are then fed back to each production process[*4] within a predetermined period of time so that necessary control for the operating conditions of the refining equipments can be made. This testing, feedback and control allows gas and oil in the production processes to maintain a sufficient quality level of low sulphur content and eventually supports environmental management and appropriate operation management[*5] of the oil refining equipments.

- Blending process

  Fuel oil going through the production process is controlled by the sulphur specification value set for each fuel oil and oil product so that it can be shipped as acceptable fuel oil and oil products. Samples are taken from the tanks (off-site) for testing and analysis in the laboratory, and the results of sulphur concentrations are identified. The test results are fed back to the blending process within a predetermined period of time so that fuel oil and oil products that comply with the sulphur specification value can be shipped. This procedure ensures sufficient quality for each fuel oil and oil product.

*1: A typical oil refinery is composed of the "production management section," the "operating section that executes production," the "maintenance section," the "financial section," and the "environment and safety section."

*2: Crude oil is a mixture of hydrocarbons of a wide range of boiling points that contains sulphuric contents, nitrogen, oxygen and

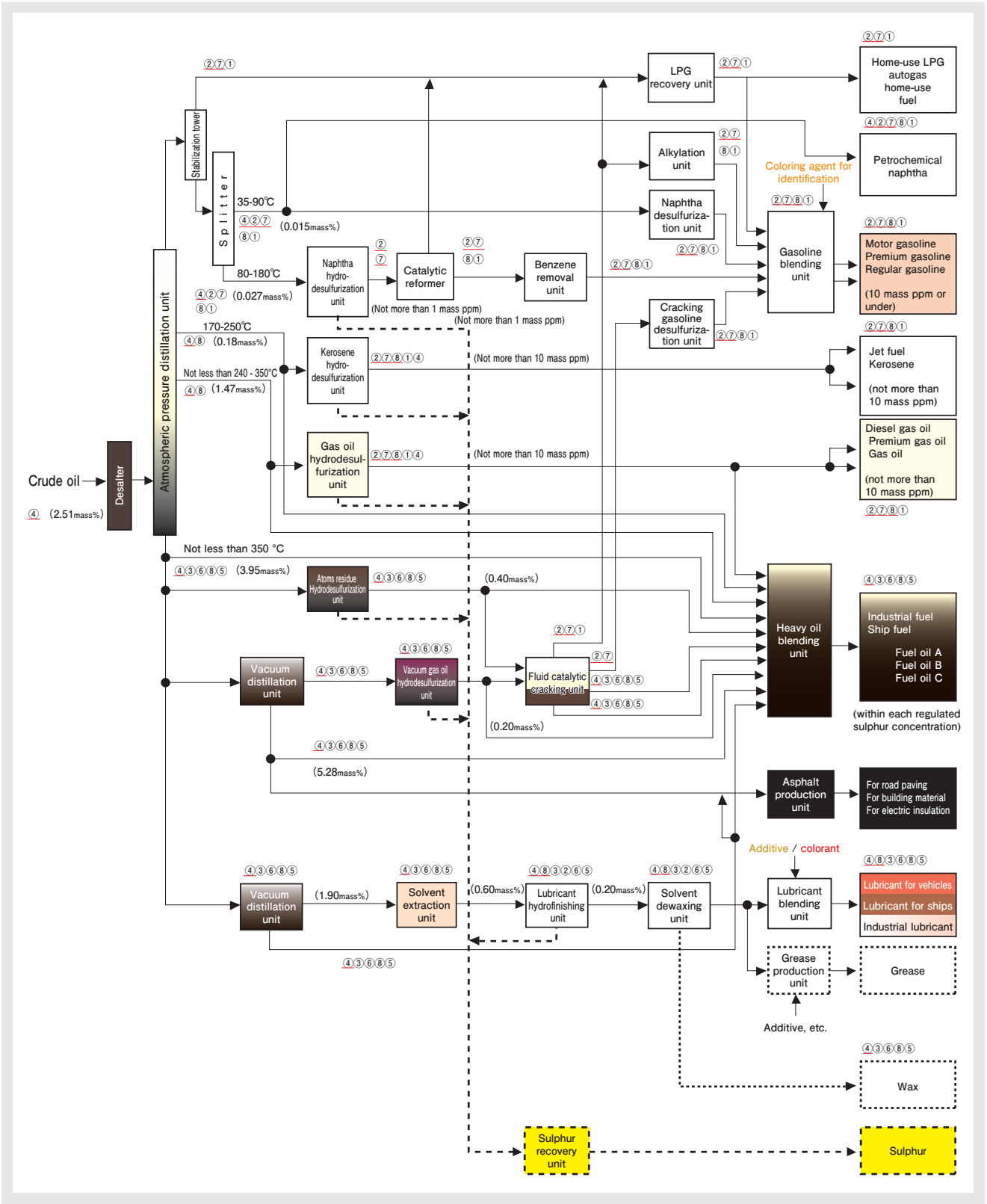

Figure 1 Example of oil refining process

Parenthesized values show the general changes in sulphur concentration.

(1) to (8) correspond to the numbers in Table 1 and indicate total sulphur content testing methods appropriate for samples. In general, the underlined numbers are employed.

metals. Crude oil from the Middle East has a large sulphuric content.

*3: Reduction in environmental impacts such as air pollution, water pollution, or waste.

*4: In addition to the test results from the laboratory, process analyzing meters are installed at appropriate locations in the refining equipment.

*5: It includes cost reduction, productivity enhancement or promotion of energy saving.

Difference between the Laboratory in the Oil Refinery and Other Testing and Analyzing Institutes

Laboratory in the Oil Refinery

Operation Status of Oil Refinery

Since oil products are continuous products, the refining equipment is generally operated 24 hours a day except for periodic inspection and maintenance. When the start-up or operation conditions of the equipment are changed[*6] or the equipment is shut down, the refinery generally takes appropriate measures to ensure safety and quality to avoid occurrence of anomalies or troubles. In case any anomaly occurred, the following damage may result depending on the severity:

- Quality anomaly affects the production and shipment plan of the refinery.
- Safety anomaly can shut down the refining equipment or even stop the entire refinery operation.

*6: General causes of changes include:
- Change in the type of crude oil (Arabian light to Merban)
- Change in throughput (atmospheric pressure distillation unit: 150,000 to 120,000 barrel/day)
- Change in the type of oil (hydrodesulfurization unit: kerosene to gas oil)
- Change in the octane value (94 to 104)

Relationship between Oil Refinery and Laboratory

As explained in Introduction, the laboratory is obliged to notify the production process, blending process and shipping process of the measured sulphur concentration, and there is always the time limit for such notification. If notification delayed or the sulphur analyzer of the laboratory fails, it could cause functional deterioration of the refinery and, in the worse case, can shut down the entire operation. The laboratory is typically operated non-stop 365 days a year.

Other Testing and Analyzing Institutes

Unlike laboratories in oil refineries, typical testing and analyzing laboratories of research centers, public quality and environmental monitoring institutes, and private analyzing laboratories do not generally provide round-the-clock support for production operation nor have the capability to "provide test results within a short period of time" as necessary for quality inspection before shipment.

- Testing and analyzing laboratories of research centers
  They provide reports on the test results of sulphur concentration for samples for development of production technology or improvement and development of products within a predetermined period of time at the request. They may also be involved in development of testing and analyzing techniques.
- Public quality and environmental monitoring institutes and private analyzing laboratories
  They provide the clients with reports on test results of sulphur concentration using the samples given by the clients within a predetermined period of time.

Sulphur Analyzer (Total Sulphur Content) Required by the Laboratory

Requirements and Priorities

Table 1 lists various techniques for analysis for total sulphur content. In general, the technique that fits the type of sample to measure and its total sulphur content is selected for analysis. Laboratory staffs use a variety of testing and analyzing apparatuses in addition to the sulphur analyzer to conduct testing and analysis. This is the background of the requirements for a laboratory with respect to sulphur analyzer. The major requirements are listed below in order of priority:

- To have the performance that complies with the national standards and other officially certified testing methods and the ability to ensure traceability
- The after-sale service of the manufacturer should be flexible and responsive
- Operations such as start-up, preparation of analytical curves, measurement and shutdown should be simple and quick
- Should be excellent in safety, durability and stability

Table 1 Kinds of total sulphur content testing methods
(1) to (8) correspond to the numbers in Figure 1.
Symbols in Table 1 are; ◉: most suitable, ○: suitable, △: available but unrecommended

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kind of testing method		Wickbold combustion method	Oxidative microcoulometry	Quartz-tube combustion method (Air method)	Energy-dispersive X-ray fluorescence method: (Calibration curve method)	General bomb method	Inductively coupled plasma emission method: ICP	Ultraviolet fluorescence method	Wavelength-dispersive X-ray fluorescence method (calibration curve method)
Analytical technique		Combustion (sulfate ion) dimethylsulfonazo III titration	Oxidative decomposition (SO_2) coulometric titration	Combustion (SOx → sulphuric acid) neutralization titration	Non-destructive	Combustion oxidation (SOx → sulfate) $BaSO_4$ gravimetric method	S free radical emission spectrometry	Oxidative decomposition (SO_2) ultraviolet fluorescence method	Non-destructive
Japanese Industrial Standard number		JIS K 2541-1	JIS K 2541-2	JIS K 2541-3	JIS K 2541-4	JIS K 2541-5	JIS K 2541-5	JIS K 2541-6	JIS K 2541-7
International standard number		ISO 4260	DIS 16591		ISO 8754			DIS 20846	DIS 20884
ASTM standard number			ASTM D 3120		ASTM D 4294	ASTM D 129		ASTM D 5453	ASTM D 2622
Types of oil (example)	Crude oil			◉	◉	◉			○
	GAS (such as LPG)	◉	◉					◉	
	Gasoline	◉	◉		○			◉	◉
	Kerosene	◉	◉		○			◉	◉
	Gas oil	◉	◉	◉	◉			◉	◉
	Heavy oil			◉	◉	◉	◉		○
	Lubricant (without additive)	△	○	○	○	◉	◉	△	○
	Lubricant (with additive)			△		○	◉		○
	Wax			△	○				○
	Asphalt for fuel			△	△				○
	Asphalt			△	△				○
	Grease								○
	Sludge			○					
Measurement range	Values specified in JIS K 2541	1 - 10,000 ppm by mass	1 - 1,000 ppm by mass	0.01 or more in % by mass	0.01 - 5 % by mass	0.1 or more in % by mass	0.05 or more in % by mass	3 - 500 ppm by mass	5 - 500 ppm by mass
	Values specified by manufacturer (example)		0.1 - 1,000 ppm by mass		0 - 6 % by mass			0.05 - 10,000 ppm by mass	0.1 - 40,000 ppm by mass

and have low running cost

Examples of Requirements

- Performance

  Measurement range, precision (determination lower/higher limit, accuracy, repeatability, reproducibility), analytical curve (preparation accuracy, range, automatic/manual, degree, number, synthesis, long-term stability, standard sample), durability, measurement-suited sample (liquid, semi-solid, temperature), 24-hour continuous operation

- Functions

  Automatic sample changer (continuous measurement, interruption, addition, deletion, possibility of thinned-out operation of samples), input of conditions and the number of inputs recordable, automatic correction, data output and recording, screen indication (brightness, clear picture), LAS communication

- Operation

  Personal difference (maturity, suitability), workability (posture, movement, sight line, height, minuteness, degree of fatigue, dominant hand), ease of start-up/shutdown, time (assembly/disassembly), ease of measuring plane checking, working space, ease of change of measuring elements

- Safety
  Discontinuation, startup indication lamp, earth-leakage breaker, protective circuit, alarm, prevention of erroneous setting, error message, indication of dangerous parts or warning parts, emergency (automatic shutdown, manual shutdown)
- Others
  Configuration (integrated type, composite type: measuring element and control element, PC, printer, interface), size (external dimension, weight, shape), material, standard accessories and quantities, price (main body, option and consumable), use environment (temperature, humidity, wind), utility (electricity), after-sale service, rating of sulphur analyzer (JIS-compliant item, traceability, sales records), supply system (main parts, option parts, consumables), inspection method (daily, periodic, manufacturer), instruction manual (ease of understanding, ease of user's preparation of operation sheet, DVD or floppy disk), installation work, labor, and explanatory contents associated with load-in, and disposal method (main body, option, consumables), sample container (quantity, heat resistant temperature), anti-earthquake measures (slip stop, fixing method), etc.

Negotiation between Purchasers and Manufacturers

These days, the laboratory staffs rarely negotiate with the manufacturer directly as the purchaser's side. It is therefore very important for the laboratory staff to check the requirements (specifications) in detail and convey their request to the purchasing staff. But in reality, requirements are not fully examined in many cases. Coupled with the lack of information and knowledge on the users on the part of the manufacturers, purchasing contracts are often completed with no sufficient check of the requirements made by either side. Controversies that are later disclosed can only depend on the relationship of trust between the purchasers and the manufacturers. It is therefore essential to carefully examine the requirements and the information exchanged between the two parties to avoid such cases.

Conclusion

Whether the result of the negotiation between the purchaser and the manufacturer is good or not has a serious impact on the laboratory staff on the purchaser's side. It is also related to the level of trust on the manufacturer's side. And negotiation let the manufacturer to know the selling point and the weak point. Such negotiations can also be used as valuable time for the manufacturer to think up better products. This is how I feel about those negotiations, and how about your idea? Whenever I have a chance, I intend to come up with better ways to select testing and analyzing equipment for the laboratory people. I hope that my article will be of help to the readers as much as possible.

(Publication members have responsibility for the translation)