ULTRA HEAVY OIL REFORMING TECHNOLOGY

REPORT

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（Ⅰ）The background and objectives of this study

Petroleum presently accounts for more than forty percent of all primary energy in Japan, however factors in life-style trends as well as industrial demands such as the growing tendency for the use of heavy oils, a reduced demand for petroleum products and drastic changes in crude oil prices have created instability in the market.

Under these circumstances, technology which enables petroleum products to be more value-added as well as diversifying sources of supply and effective conversion to heavy oils are being sought in order to secure stable supplies of petroleum. Technical difficulties with the extraction and production of white oils such as gasoline and kerosene from ultra heavy oils such as oil sand and Orinoco tar have led to increased production costs.

Consequently the development of oil sands is highly dependent on crude oil prices.
Given the above, this study aims at establishing an effective usage of extremely low quality fuel oils both economically and technically.

（Ⅱ）Outline

In this study we looked at the possibility of upgrading bitumens such as oil sand of which we have rich reserves and ultra heavy oils by reforming them using the physical crushing technique of our continuous cross-collision apparatus "SLIC SYSTEM" into heavy oils which conform to the quality standards principally as apply for the fuels of large-sized vessels.

To be specific, we examine the following three items.

① Verification of the crushing of metal residue which is a major component of ultr heavy oils and can seriously damage an internal combustion engine and its result.

② Verification of the reduction in kinematic viscosity which typically acts as a restraint to reducing costs in every process from storage to transportation and a study of the solutions for various problems including the problem of separation.

③ verification of the reduction in the molecular weight of asphalt which is an ultra large molecule through the process of cross-collision at high temperature and pressure and an analysis of changes in the combustion properties accompanying the reduction of molecule weight.

（Ⅲ） The contents of the test

We examine the extent to which micelles in asphaltene can be crushed by physically using our continuous cross-collision apparatus "SLIC" SYSTEM.

- Heavy oil used ; C-3 oil, kinematic viscosity 650～700cSt（at 50 ℃）
- Pressure applied ; 200Mp　We use kerosene to prevent the crushed micelle from reforming.
- Evaluation items ; kinematic viscosity (at 50℃), flash point, gross calorific value, particlesize distribution, and distillation under reduced pressure.

cross-collision apparatus
“ＳＬＩＣ” SYSTEM

(V) The evaluation of the test-② Consideration

Kinematic viscosity ----- Compared with fuel oil C which is a crud oil, kinematic viscosity of the reformed heavy oil decreased by about seventy percent and this is close to 180 cSt (at50℃) which is a standard value for fuel oil C -1.

Flash point ----- By adding an aggregation prevention agent (kerosene) the flash point was lowered became lower than 70℃ which is a standard value of fuel oil C-1

Gross calorific value ----- Calculations using the specific gravity of the samples based upon the result of analysi we found no changes in gross calorific va after reforming. However combustion tests demonstrate less unburned carbon (black smoke) and therefore the real or effective calorific value increases.

Particle diameter of residue - It became clear that C-1 crude oil of which maximum particle size is 4μm is crushed into 50% of size using an aggregation preventio agent of ten percent kerosene. However thos numerical values in the above table are the result of measurement by volume distribution. If measured by number distribution under pressure of more than 200Mpa at 128.6℃（theoretical value）, C-1 crude oil can be crushed up to 0.1 μm.1/40 in length which results in 1/64,000 in volum and therefore we may claim this as an effective heavy oil reforming technique.

Distillation under reduced pressure ----- Distillation temperature was lowered drastically by up to 30 volume percentage and this can be considered that with addition of an aggregation prevention agent (kerosene) the noncombustible asphalt component was broken up (crushed) and the aggregate dispersed thereby reducing its molecule weight.

(Ⅳ) The evaluation of the test－① The result of the analysis

No.	Item	Units	Fuel oil C-3	Reformed fuel oil	Test methods
1	Kinematic viscosity	㎟/s(cSt)	650	191*1	JIS K2283
2	Flash point	℃	112	68	JIS K2265-3
3	Gross calorific value	J/g	42,480	42,250	JIS K2279
4	Mean particle size of residue				
	10%D	µm	2,356	1,835	*2
	50%D		3,935	2,605	
	90%D		6,602	3,469	
	The mean		3,902	2,554	
	Distillation under reduced pressure				
5	Initial boiling point	℃	199	182	JIS K2254*3
	5 volume %		255	220	
	10 volume %		296	241	
	20 volume %		367	285	
	30 volume %		422	342	
	40 volume %		470	494	
	Decomposition point		546	540	
6	Combustion properties				
	Amount of black smoke emitted		Large	Very small	Visual inspection*4

*1 ; Measured using our kinematic viscosity measuring unit (A & D Company Limited make SV-10 viscom.

*2 ; Measured using Laser particle size distribution measuring apparatus (Shimadzu corporation make SALD-2100)

*3 ; Measured at Physical & Chemical Analysis Center of Nippon Kaiji Kentei Kyokai

*4 ; Conducted a combustion test using our burner and inspected visually the Black smoke emitted.

（Ⅵ） Summary

Extrapolating from the analysis above, we propose that heavy oils, which at the present levels of technology cannot suitably be used as fuel, may be reformed up to a level with heavy oil C-1, C-2. A tendency toward cracking heavy oils into white oils for use as transportation fuels or high value-added petro-chemical materials can alleviate the current supply and diversification problems as well as reducing the quantity of pollutants added to the environment.

Using the above technology in conjunction with existing technologies such as desulfurization can not only permit the use of low cost heavy oils without detriment to the environment but also reduce the maintenance issues incurred through damage to diesel engines and related components; piping, tank systems and so forth.