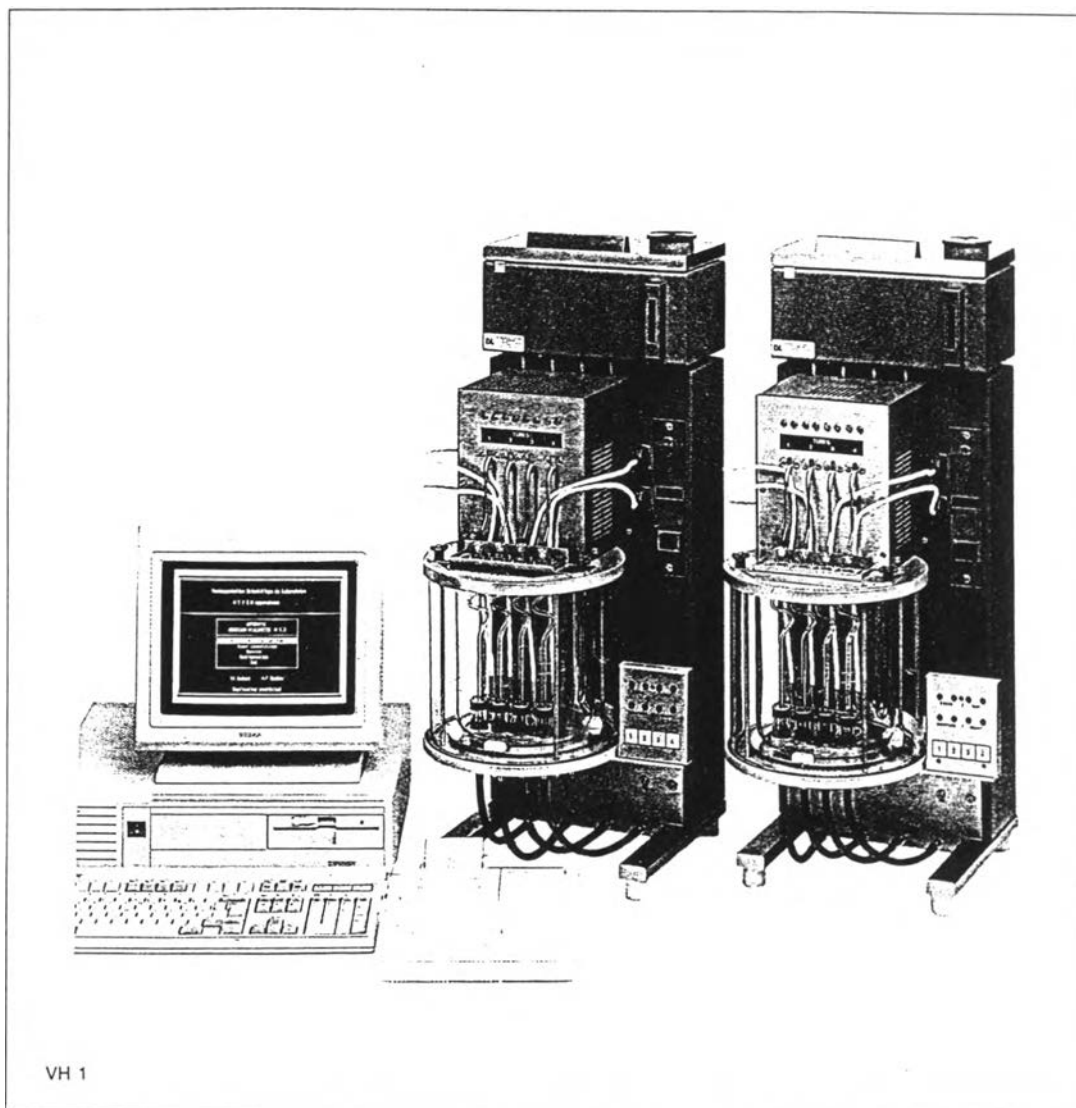


REFERENCES

- Mortier , R.M. and Orszulik , S.T. Chemistry and technology of lubricants. London : Blackie and Son Ltd. , 1992.
- Klamann , D. Lubricants and related products. Weinheim : Verlag Chemie GmbH ,1984.
- Miller , R.W. Lubricants and their applications. New York :McGraw-Hill ,Inc. 1993.
- The Institute of Electrical and Electronics Engineers , Inc. Reclamation of insulating oil and criteria for its use. New York : The Institute of Electrical and Electronic Engineers , Inc. ,1985
- The Lubrizol Corp. Ready guid reference for lubricant and fuel performane. USA : The Lubrizol Corp. , 1991.

APPENDIX A

AUTOMATIC HOUILLON VISCOMETER



VH 1

ATPEM
ASTM D 341 - D 445
D 2270

The key point of the Houillon technique is to use a small quantity of sample (200 to 400 microliters). Hence measurement is performed very quickly and accurately.

At the end of each assay an automatic cleaning and drying sequence is carried out. Solvent usage is minimal.

This automatic viscometer can determine up to 16 kinematic viscosities values simultaneously using the Houillon capillary method.

The instrument includes a compatible micro-computer to which 1 to 4 baths can be connected each one holding 4 capillaries.

CHEMICAL HOUSE LTD., PART.
1937/23-24 SBI NAVASRI
RAMKHAMHANG ROAD (2)
BANGKOK 10240
TEL. 3100702 3 3121739
X 0000 0000



APPENDIX B

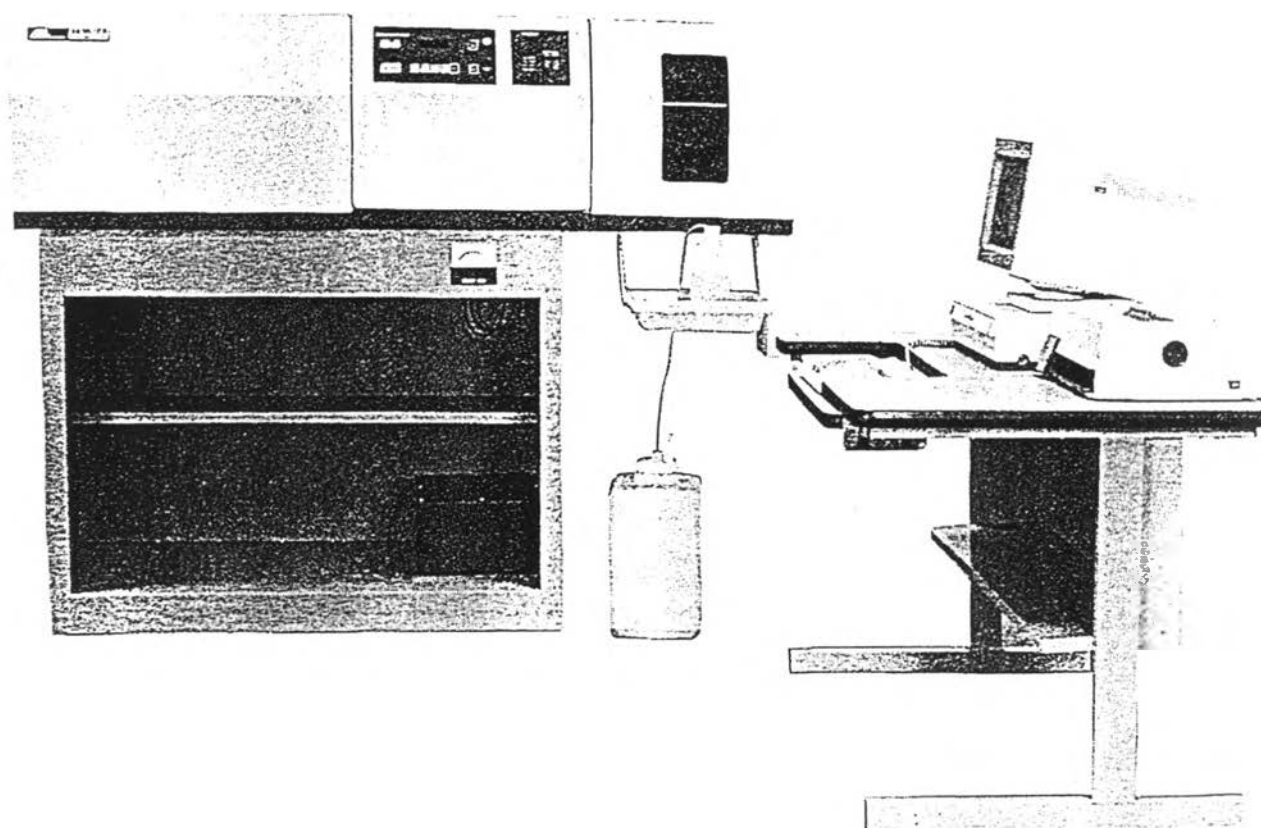
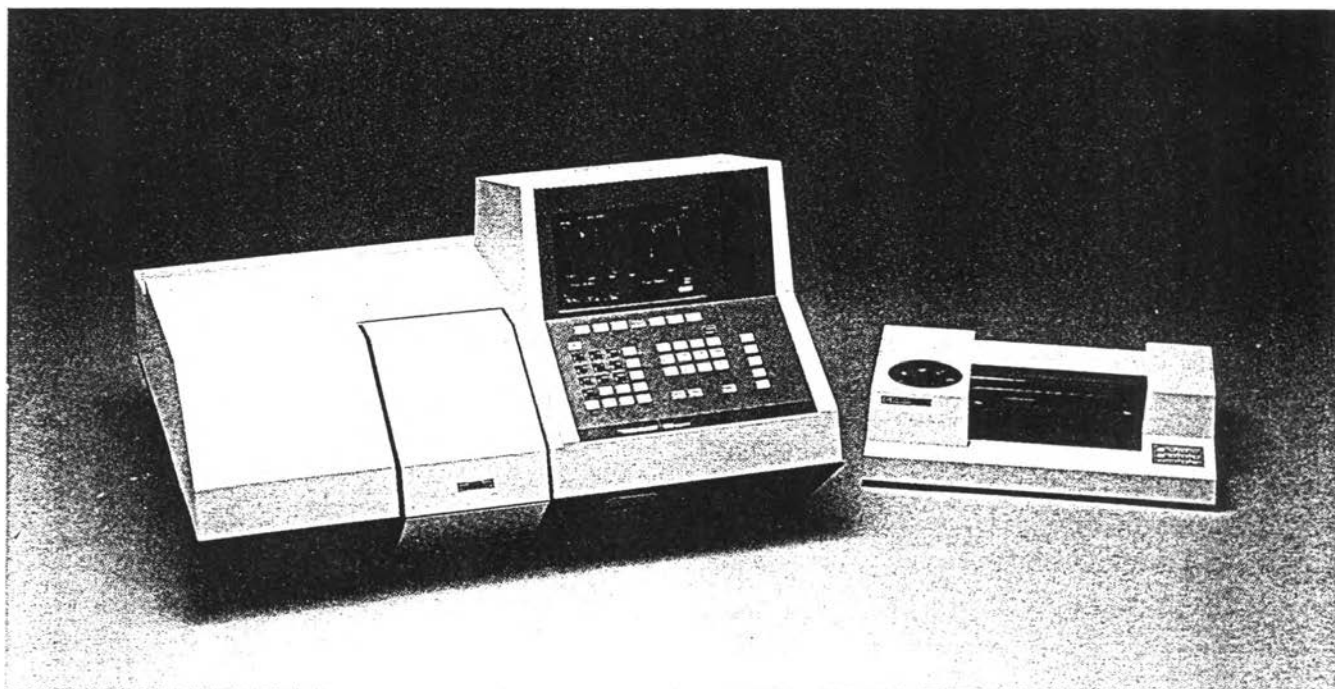


Figure 1.1. Model 3410+ ICP Spectrometer System

APPENDIX C



The Perkin-Elmer Models 1620 and 1650 are integrated FT-IR spectrometers designed for use in the analytical or quality control laboratory. The 1600 Series combines the speed of FT-IR, comprehensive software and fast, interactive graphics to give both versatility and ease of use.

All of the spectrometer control and spectroscopic calculator functions appear on a simple, color coded keypad. The spectroscopic calculator consists of a series of routines which include Compare, a spectral matching function specifically designed for quality control analysis, Derivative, Kubelka-Munk, and MIR correction. These routines and spectrometer control functions can be combined in methods, allowing long or repetitive analyses to be performed with a single keystroke. Methods and spectra can be stored using the 1.2 MB 5.25 inch floppy disk drive. The multitasking capability of the 1600 Series allows scanning, plotting, printing and data manipulation, all at the same time. In addition to being able to use standard IR accessories a variety of optimized accessories have been designed specifically for Perkin-Elmer FT-IR spectrometers. There is also an external bench available, which can be used to accommodate large or permanently mounted accessories.

The only external requirement of the 1600 Series is electricity, and the sealed and desiccated optics remove the need for purging.

FEATURES

- **Fast, interactive graphics**
In addition to being able to display up to three spectra at the same time, most data manipulation routines are interactive with spectral update in real time.
- **Presentation plotting**
Spectra may be plotted to presentation standard on plain or grided paper. Plotting options include landscape or portrait formats, peak labeling and linear wavelength.
- **Spectroscopic calculator**
Spectroscopic calculator functions such as COMPARE, a spectral matching function specifically designed for quality control analysis, are included in the standard software.
- **Learn mode for methods**
Methods may be entered using either the learn mode or the screen editor, allowing a complete analysis to be executed with a single keystroke.
- **Optimized accessories**
In addition to standard accessories there is a range of optimized accessories available.
- **External beam**
The 1600 Series has an external beam facility which may be used with an external bench for large and permanently mounted accessories, or with an IR microscope.

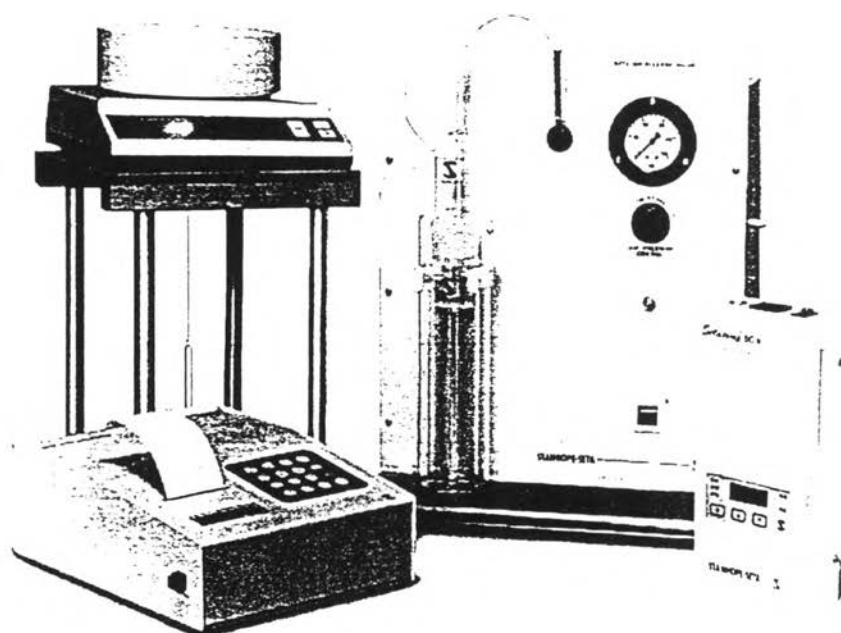
APPENDIX D

STANHOPE-SETA



SETA AIR RELEASE VALUE APPARATUS

Gas Bubble Separation Time of Petroleum Oils
 ASTM D3427; NF E48-614
 Air Release Value
 IP313; BS 2000 Part 313; DIN 51 381



15880-3

15850-3

- Digital temperature control and display
- Air pressure control and regulation
- Safety over-temperature cutouts
- Precision electronic density balance with Seta Data Processor
- Print-out of results
- Automated end point detection
- Aeration timer

STANHOPE-SETA



HEAD OFFICE, MARKETING AND LABORATORIES.

PARK CLOSE, ENGLEFIELD GREEN, EGHAM, SURREY TW20 0XD, U.K.

TEL: National 01932 564391 International +44 1932 564391 FAX: National 01784 430966 International +44 1784 430966 TELEX: 928677 SETA G

Stanhope-Seta has ISO 9002 certification and our facility at Chertsey, U.K. is a registered establishment.



APPENDIX E APPENDIX E



IP 313/77
(1983)



BS 2000: Part 313: 1993

Determination of air release value of hydraulic, turbine and lubricating oils¹

This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations.

1. SCOPE

1.1. This method gives a measure of the ability of an oil to separate entrained air. It is commonly applied to hydraulic and turbine oils, but may also be used for other lubricating oils. It may be used for petroleum-base lubricants or for synthetic fluids such as phosphate esters. This method may also be used to determine the rate of release of other gases from oil when the gas pressure needs to be adjusted to maintain the main gas flow rate. The precision statement does not necessarily apply to other gases.

2. DEFINITION

2.1. *The Air Release Value* – is defined as the number of minutes for air entrained in the oil to reduce in volume to 0.2% under the conditions of this test and at the specified temperature.

3. SUMMARY OF METHOD

3.1. Compressed air is blown through the test oil heated to a temperature of 25, 50 or 75°C. After the air flow is stopped, the time required for the air entrained in the oil to reduce in volume to 0.2% is recorded.

4. APPARATUS

Of the form shown in Fig. 1 and consisting of:

4.1. *Test Vessel* – of glass, as shown in Fig. 2, consisting of a jacketed sample tube fitted with an air-inlet capillary, baffle plate and an air-outlet tube. The two parts of each test vessel should be marked and used as a pair. Interchanged parts may be used so long as the resultant test vessel conforms to the stated dimensions.

4.2. *Pressure Gauge* – range 0 to 355 mbar (0 to 35.5 kPa).

4.3. *Thermometer* – range 0 to 100°C in 0.2°C intervals, IP 64C (ASTM 12C) is suitable.

4.4. *Heater* – to bring the compressed air up to measurement temperature. A coil of copper tubing immersed in the circulating bath (see 4.6 below) is suitable at 25°C, but additional heating is necessary at 50°C and 75°C and this can be obtained by an additional bath or by using a separate steam or electric heat exchanger. Measure the temperature of the air by a thermometer or other suitable means.

4.5. *Compressed Air* – filtered to remove any oil. Air from a cylinder may be used.

4.6. *Circulating Bath* – approximately 10 litres capacity with a rate flow of 10 litres/min and capable

of maintaining the test cell at a temperature of 25, 50 or 75°C within $\pm 0.1^\circ\text{C}$.

4.7. *Density Balance* – accurate to 0.0005 g/ml, with round-bottomed or tapered sinker with 5 or 10 ml displacement, 80.0 ± 1.5 mm length. If the sinker contains a thermometer, it must be usable between 25°C and 75°C.

4.8. *Oven* – capable of controlling temperatures up to 100°C.

5. REAGENTS (Laboratory Reagent Grade)

5.1. *Chrome Sulphuric Acid* – Dissolve 50 g of potassium dichromate in one litre of concentrated sulphuric acid (98%). Store in a glass bottle with a ground glass stopper.

CAUTION: *This solution is strongly acidic and is a powerful oxidizing agent. Protective clothing including eye/face shield, should be worn when it is handled. Splashes on the skin should be immediately and thoroughly washed with water.*

5.2. *1,1,1-Trichloroethane*.

CAUTION: *1,1,1-Trichloroethane when heated to decomposition produces highly toxic fumes.*

5.3. *Acetone* – to BS 509.

5.4. *Distilled Water* – to BS 3978.

6. PREPARATION OF APPARATUS

6.1. Clean the interior of the test vessel including the air inlet and sinker, and all other glassware coming into contact with the sample, before each determination in the following manner. Rinse away the oil residue with 1,1,1-trichloroethane and dry by air blowing. Clean the apparatus by immersing in chrome sulphuric acid for a minimum period of 12 h in order to completely remove any traces of silicone. Rinse with distilled water until the washings are free from acid, then rinse with acetone and dry with clean compressed air.

PROCEDURE

7.1. Assemble the test apparatus as shown in Fig. 1. Set the circulating bath to the test temperature.

7.2. Warm 200 ml of the oil to be tested in an oven set at a temperature of 10°C higher than the test temperature.

7.3. Pour 180 ml of the warmed sample into the test vessel.

7.4. Allow the sample to reach the test temperature. This usually takes about 20 min.

7.5. Warm the sinker of the density balance to the test temperature in an air bath, such as a glass

¹ This method is technically identical with DIN 51381 and ASTM D3427.

AIR RELEASE VALUE, IP 313

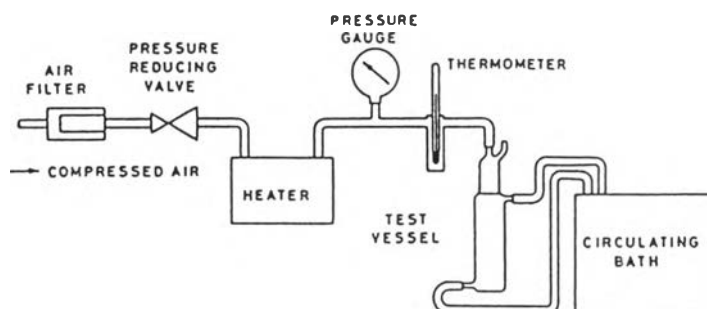


Fig. 1. Assembly of apparatus.

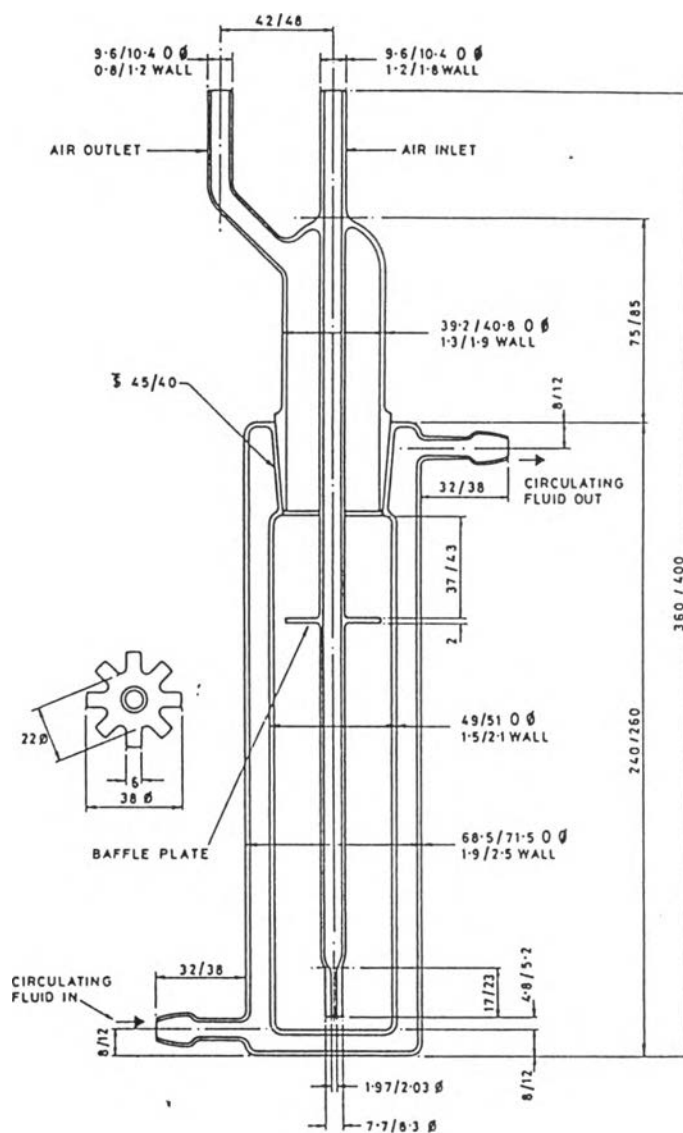


Fig. 2. Test vessel.

cylinder fitted with a suitable cover situated in the circulating bath. When the sinker has reached the test temperature, immerse it in the sample taking care that no air bubbles cling to it. Attach the sinker to the beam of the density balance by means of the platinum wire so that the bottom of the sinker is 10 ± 2 mm from the bottom of the test vessel.

7.6. Read the density from the balance to the

nearest 0.001 g/ml and record it as the initial density d_0 .

7.7. Return the sinker to the air bath and replace with the air inlet tube as shown in Fig. 2. After 1 min, start the supply of air at a gauge pressure 200 mbar (20 kPa) at the test temperature. Maintain the pressure and temperatures by readjustments necessary.

AIR RELEASE VALUE, IP 313

7.8. After 420 ± 1 sec (7 min) shut off the air and quickly remove the inlet tube from the test vessel. Immediately start the timer and set up the balance in its original position in relation to the cell and attach the wire to the beam [Note 1].

NOTE 1: In the case of certain oils which form a considerable volume of oil/air dispersion the top of the sinker may initially be in foam and hence density readings at the time may be in error.

7.9. Change the balance setting to correspond to 0.2% of air by volume ($d - 0.0017$), and record the time from shutting off the gas until the balance passes the null point. When using a direct reading density balance, record the time for the balance to reach $d_0 - 0.0017$. If the null point is not reached within 30 min, discontinue the test. [Note 2].

NOTE 2: The value of 0.0017 g/ml refers to an oil of density 0.850. For other densities this value changes by 0.0001 for each 0.05 change in density, i.e. it will be 0.0016 at 0.800 and 0.0020 at 1.000.

7.10. Alternatively where the air release-time curve is required proceed as follows. After 1 min from the time the air is shut off, read and record the density to the nearest 0.001 g/ml at d_1 , and thereafter at 60 sec intervals until the value $d_0 - 0.001$ g/ml is reached. If the time separation exceeds 15 min continue to read the density but at intervals of 5 min up to a total maximum of 30 min.

Plot a curve of density against time. The time at which the sample reaches 0.2% volume of entrained air can then be read directly from the graph and is given by $d_0 - 0.0017$ g/ml.

8. REPORT

8.1. Report the Air Release Value, IP 313, at (temperature) $^{\circ}$ C. Times up to 15 min shall be recorded to the nearest 0.1 min, and those from 15 to 30 min to the nearest min.

9. PRECISION

9.1. The following precision data, reproduced from the German standard DIN 51 381, may be used for judging the acceptability of results (95% confidence.)

Repeatability: Duplicate results by the same operator should be considered suspect if they differ by more than the amounts shown in the following table.

Reproducibility: The results submitted by each of two laboratories should not be considered suspect unless they differ by more than the amounts shown in the following table.

Air Release Value (ARV) Min	Repeatability Min	Reproducibility Min
Up to 5	1	2
Above 5 to 10	2	3
Above 10 to 15	3	4

VITA

Mr.Chayuth Temnitikul was born on January , 1966 in Surat-thani , Thailand. He received his Bachelor Degree of Science in Chemistry from Faculty of Science of Prince of Songkhla University in 1988. He started working with Castrol (Thailand) Ltd. since 1988 as a chemist. Now he still works there as the Pricipal Chemist.