KUWAIT 3RD FLOW MEASUREMENT TECHNOLOGY CONFERENCE

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HILTON KUWAIT RESORT , AL DORRA BALLROOM

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شركة نفط الكويت
Kuwait Oil Company

إحدى شركات مؤسسة البترول الكويتية
A Subsidiary of Kuwait Petroleum Corporation

SHERIF KOREISH

Sampling Methods & Laboratory Analysis

Inspectorate – BV Company

Sampling Methods & Laboratory Analysis

- Petroleum Quality is important in all transactions and Operations and is of great importance to Producers, Traders, Refiners, etc.
- Samples of petroleum and petroleum products are obtained for many reasons, including the determination of chemical & physical properties.
- These properties may be used for:

  Calculating standard volumes;

  Establishing product value;

  Safety and regulatory reporting.

- A **Sample** is the basis upon which Cargos are delivered and Payments are made.

Sampling Methods & Laboratory Analysis

- The Quality of the Commodity is based on the Sample Taken

“The Analysis is as Good as the Sample”

- Standards that Govern Sampling Methods are as follows:

API MPMS Ch. **8.1** - Manual Sampling	(ASTM D4057)
API MPMS Ch. **8.2** - Automatic Sampling	(ASTM D4177)
API MPMS Ch. **8.3** – Mixing & Handling	(ASTM D5854)
API MPMS Ch. **8.4** – Sampling of Volatiles	(ASTM D5842)

Sampling Methods & Laboratory Analysis

- **Manual Sampling**

The objective of manual sampling is to obtain a small portion of material from a selected area within a container that is representative of the material in the container.

- A Small Portion to be made Representative of the Large Quantity

- Common factors that affect the quality of the samples are:

Non-homogenous material

Temperature

Volatility

Density

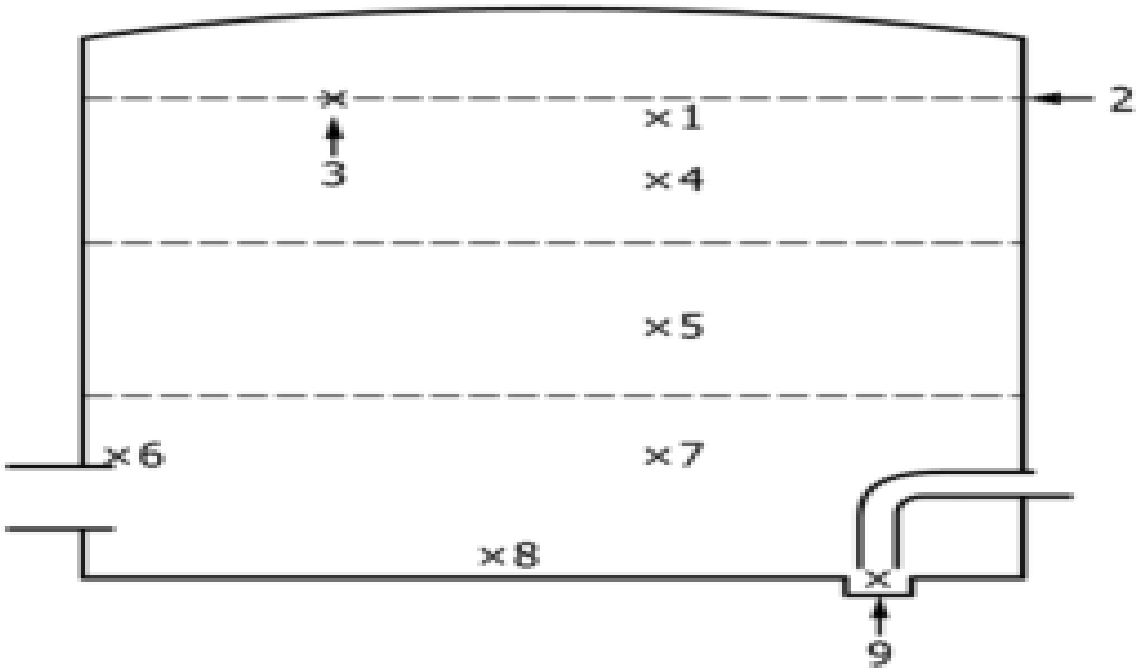
Free Water

Fluidity

Sample Handling

Sampling Methods & Laboratory Analysis

- **Common Sampling Positions**

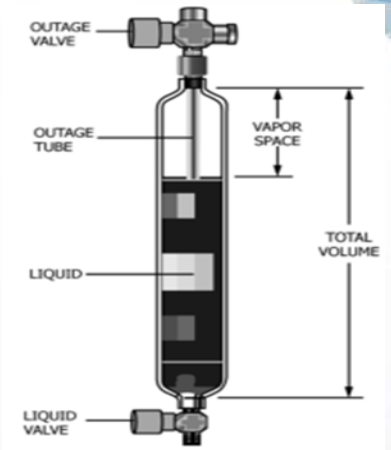


Key

1	Top sample	6	Suction level or outlet samples
2	Surface of product	7	Lower sample
3	Skim sample	8	Bottom sample
4	Upper sample	9	Sump sample
5	Middle sample		

Source ASTM D4057

Sampling Methods & Laboratory Analysis



- **Types of Manual Samples**

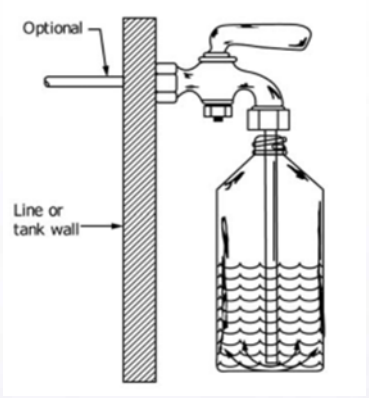
  - Spot Sample
  - All Level Sample
  - Running Sample
  - Zone Sample
  - Composite Sample
  - Representative Sample

- **Types of Samplers**

  - Tap Samplers
  - Zone/Core Sampler
  - Cage & Bottle Sampler
  - High Pressure Sampler (Cylinder)
  - Closed/Restricted Samplers

Sampling Methods & Laboratory Analysis

- **Sampling Equipment**
  - Natural Fiber Cords or Chains
  - Bottles or Cans - Amber or Clear
    - Ensure Container does not Contaminate Sample
  - Sample Thief
    - Bottle and Cage
    - Beaker
    - Zone Sampler
    - Bacon Bomb
    - Tulsa Thief



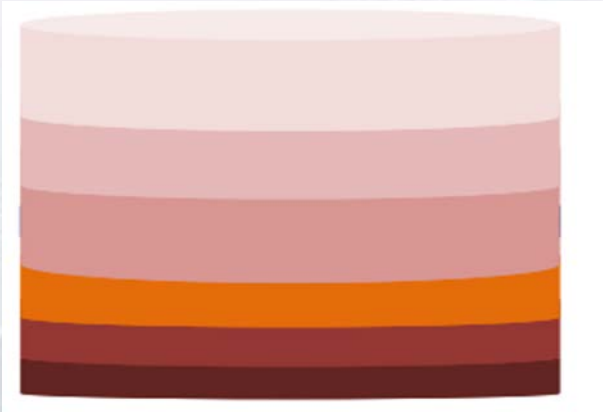
Sampling Methods & Laboratory Analysis

► Limitations of Manual Sampling

- Running & All-Levels Samples
  - One Sample Representing an Entire Tank
  - Fill Rate Varies with Depth
  - Difficult almost Impossible to take samples at consistent rate

- Spot Samples
  - Representative is unknown
  - Upper - Middle - Lower for Stratification
  - Critical Specifications
  - Three Samples to represent entire tank ?

Tanks are not Homogeneous



Sampling Methods & Laboratory Analysis

- **Applications & Containments**

TABLE 3 Typical Sampling Procedures and Applicability

Application	Type of Containment/Vessel/Tank	Procedure
Petroleum liquids	Storage tanks, tank cars, tank trucks	Bottle sampling Zone/Core sampling Tap sampling High pressure cylinder sampling
	Marine vessels	Bottle sampling Zone/Core sampling Automatic sampling High pressure cylinder sampling
	Pipelines	Automatic sampling Manual pipeline sampling High pressure cylinder sampling
Petroleum liquids—water/sediment—bottom sampling	Storage tanks, marine vessels, tank cars, and tank trucks	Core sampling Bottom water and ROB/OBQ sampler
Petroleum liquids—water/sediment—bottom sampling	Storage tanks with taps	Tap sampling
Petroleum liquids	Drums, barrels, cans	Tube sampling
Petroleum liquids/water	Free or open discharge streams; open tanks or kettles with open heads; tank cars, tank trucks, drums	Dipper sampling
Petroleum liquids/water	Free or open discharge streams	Dipper sampling
Asphaltic and bituminous materials	Storage tanks, marine vessels, tank cars, lines, packages	Core sampling Tap sampling[A] Throw-away container sampling
Waxes, solids, bitumens, other soft solids	Barrels, cases, bags, cakes	Boring sampling
Petroleum coke, lumpy solids	Freight cars, conveyors, bags, barrels, boxes	Grab sampling
Greases, soft waxes, asphalts	Kettles, drums, cans, tubes	Grease sampling

[A] Refer to Practice D140.

Sampling Methods & Laboratory Analysis

- **Automatic Sampling**

"The Automatic Sampler is a Device used to extract a representative sample from the liquid flowing in a pipe."

- It generally consists of :

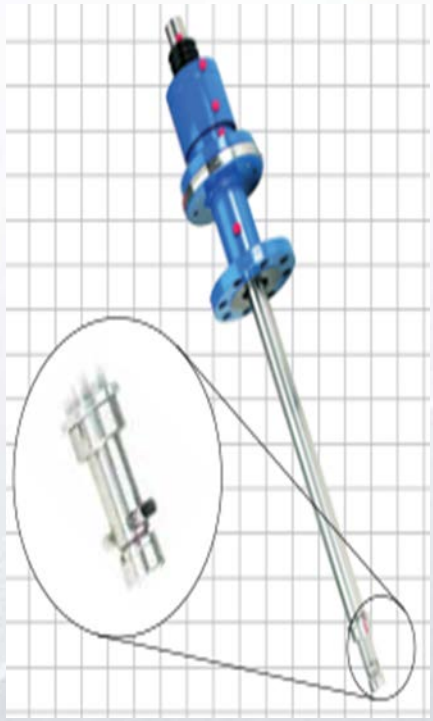
A Probe

Sample Extractor

Controller

Flow Measuring Device

Sample Receiver



Sampling Methods & Laboratory Analysis

- **Automatic Sampling**

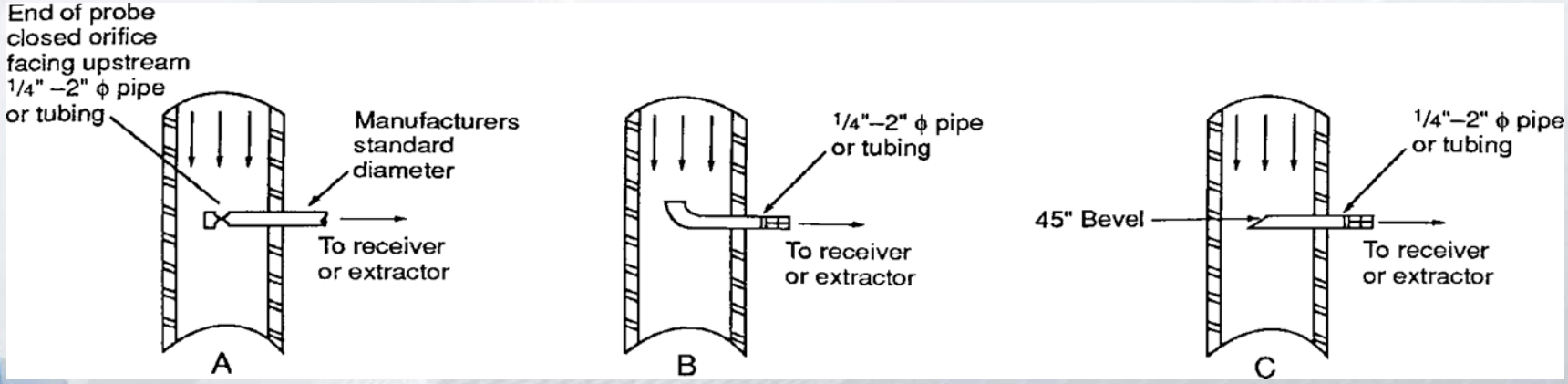
The sampler obtains **Grabs** of the sample in a flow proportional manner with consistent volume.

Sampling frequency can be given in terms of "grab per lineal distance of pipeline volume."

For marine and pipeline service this minimum guideline can be related to barrels per grab using the following equation:

$$\text{BBL/Grab} = 0.0001233 \times D^2$$

where: D = *nominal pipe diameter, mm*

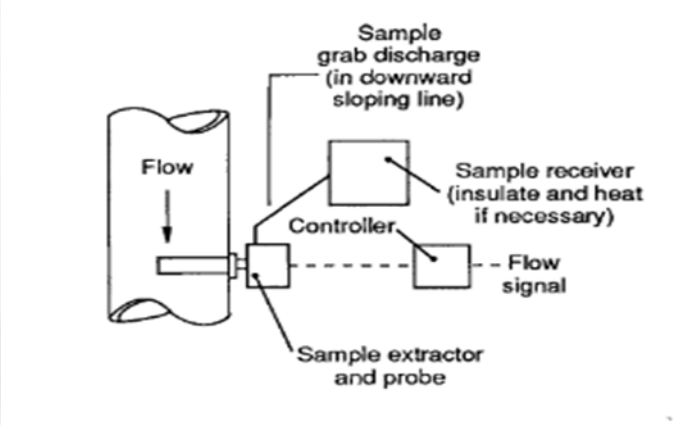


Sampling Methods & Laboratory Analysis

- **Automatic Sampling**

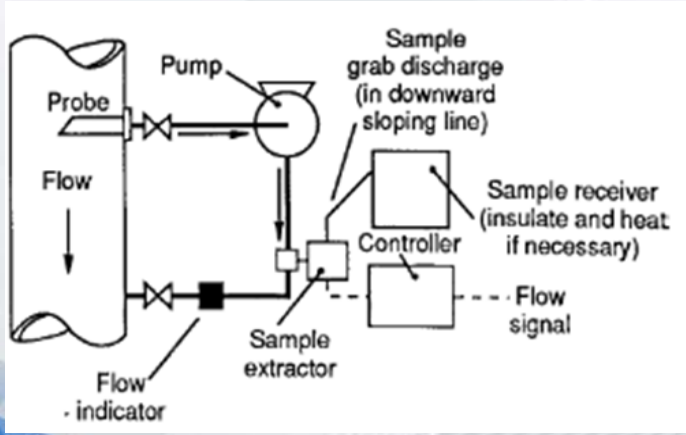
There are Two Types of Automatic Sampling Systems

- Automatic **Sampling-In-Line**



Extractor is Located in the Main Line

- Automatic **Sampling with Fast Loop**



Extractor is Located in the Sample Loop

Sampling Methods & Laboratory Analysis

- **Automatic Sampling**

Each Step of the Sampling Process Contains Uncertainty

Stream conditioning achieved by proper flow velocities

↓

Natural Turbulence or Mixers

Pipeline Mixing

↓

Sample Extraction

↓

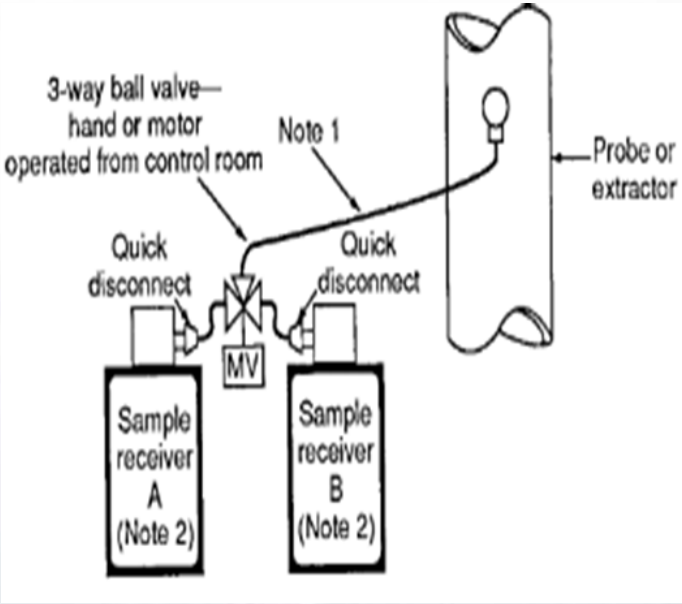
Sample Collection

↓

Sample Handling & Remixing

↓

Sample Analysis



Sampling Methods & Laboratory Analysis

- **Laboratory Analysis**

  Samples are Received for Analysis are to be properly Mixed but **AVOID** over heating and maintain representivity.

- Main **Quality Parameters** are:

Density	ASTM D5002/D1298
S&W	ASTM D4007
Sulfur Content	ASTM D4294
TAN	ASTM D664
RVP	ASTM D323
Water Content	ASTM D4928/D4006
Pour Point	ASTM D5853
Mercury	UOP 938

Sampling Methods & Laboratory Analysis

- **Laboratory Analysis**

The following is a brief **significance** of the test parameters

Density:	Grade, Quality, Quantity Calculations
S&W:	Processing for Refining
Sulfur:	Treatment, Catalyst, Emissions
TAN:	Asset Integrity/Corrosion
RVP:	Volatility, Losses
Water :	Emulsions
Pour Point:	Fluidity
Viscosity:	Fluidity
Mercury:	Asset Integrity, Catalyst poisoning
H2S:	Safety & Corrosion

Sampling Methods & Laboratory Analysis

- **Crude Oil Extraction Processes**

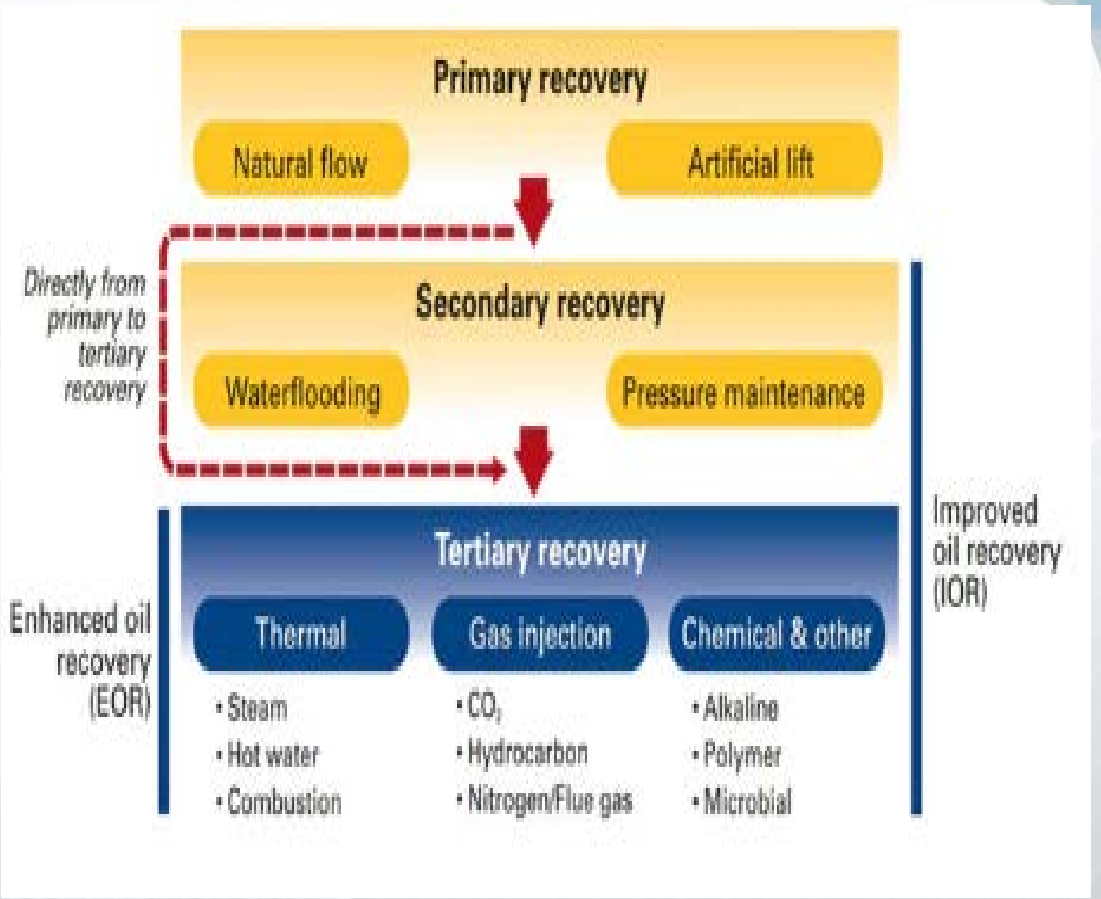
Natural Pressure
Gas Injection — 15%

↓ **Pressure Drops**

Water Flooding
Gas Injection — 45%

↓ **Pressure Drops**

Steam
Gas
Chemicals — 15%



Sampling Methods & Laboratory Analysis

- **Crude Oil Treatment**
- Treatment Can be Carried out at the production facility or at the refinery.
- Treatment can involve Mechanical/Electrical means or Additivation

Gas Separation

Demulsification

Dehydration

Desalting

Acid Treatment

H_2S Removal

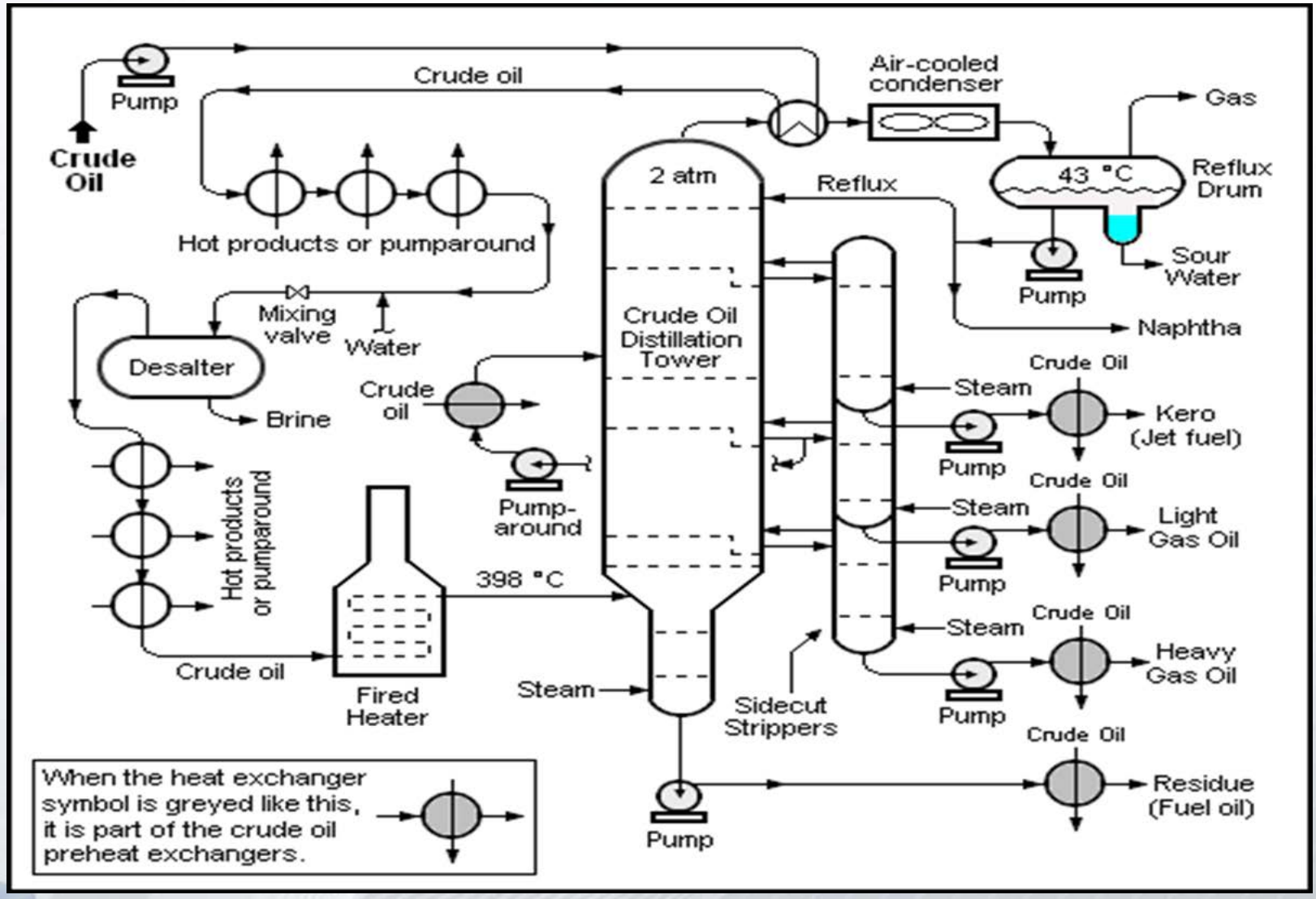
Pour Point Depression

Flow improvers

etc.

Sampling Methods & Laboratory Analysis

- **Crude Oil Basic Refining**



References

- **ASTM -** “American Society for Testing and Materials”
- **API -** “American Petroleum Institute”
- Auto Sampler Manufacturers – *Names to be provided upon request*

Thanks for Attention