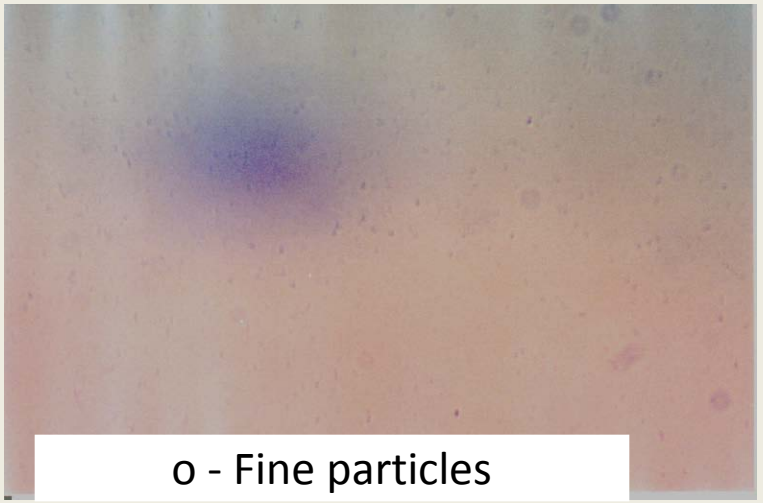
Asphaltenes

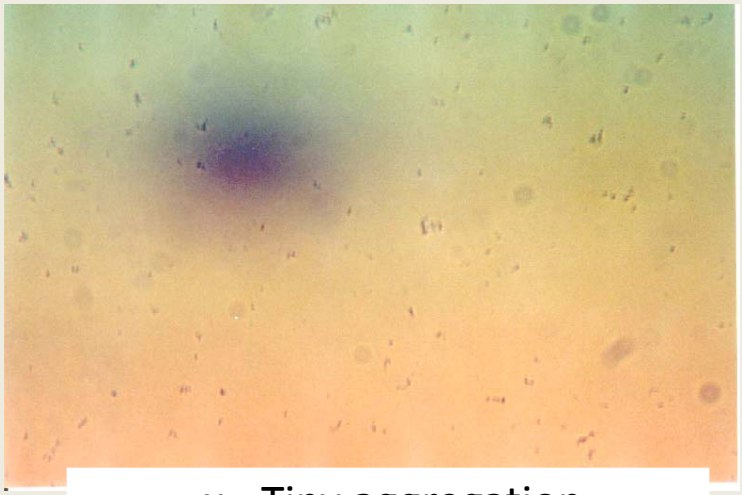
- Asphaltene exists in crude oil predominantly as a dispersion of very small (35 Angstrom) platelets that will easily pass through pore passages as they flow suspended in the oil.
- The asphaltene particles are held as distinct platelets by chemicals that form a “micelle”, principally maltenes and resins. So long as these micelles are stable, the asphaltene particles are not a significant problem in the oil.
- When chemical or physical interactions cause the micelles to break, the particles will agglomerate or stick together, and can plate out on steel or in the reservoir, changing wettability in the rock, forming deposits in piping and creating extremely viscous sludges in the oil.

Microscopic photos of asphaltene aggregation

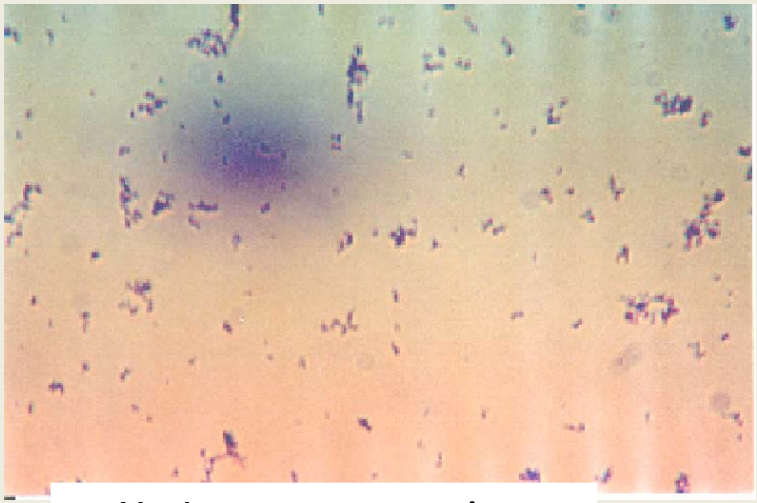
O - Nothing could be seen



o - Fine particles



x - Tiny aggregation



X - Large aggregation

Asphaltenes leave the suspension of created by the micelle when the materials creating the micelle are disturbed. The particles grow as tiny asphaltene platelets are attracted to each other. The process is not easily reversed.

Asphaltenes

- Distinguished from paraffin by being insoluble in solvents such as pentane, kerosene and diesel.
- Asphaltenes are the heaviest and largest molecules in a typical hydrocarbon mixture, but until the micelles are disturbed, they are not a plugging problem.
- Oils from which asphaltenes are likely to precipitate have low API gravity (are more dense), and have higher viscosities. The precipitation is described by phase behavior that can be predicted by testing on a representative sample from the formation.

One form of asphaltene – hard balls of dry asphaltene platelets that adhere to each other. These deposits were removed from a choke in a gas well that produced very small amounts of condensate and a little oil. Other forms are viscous tar-like masses

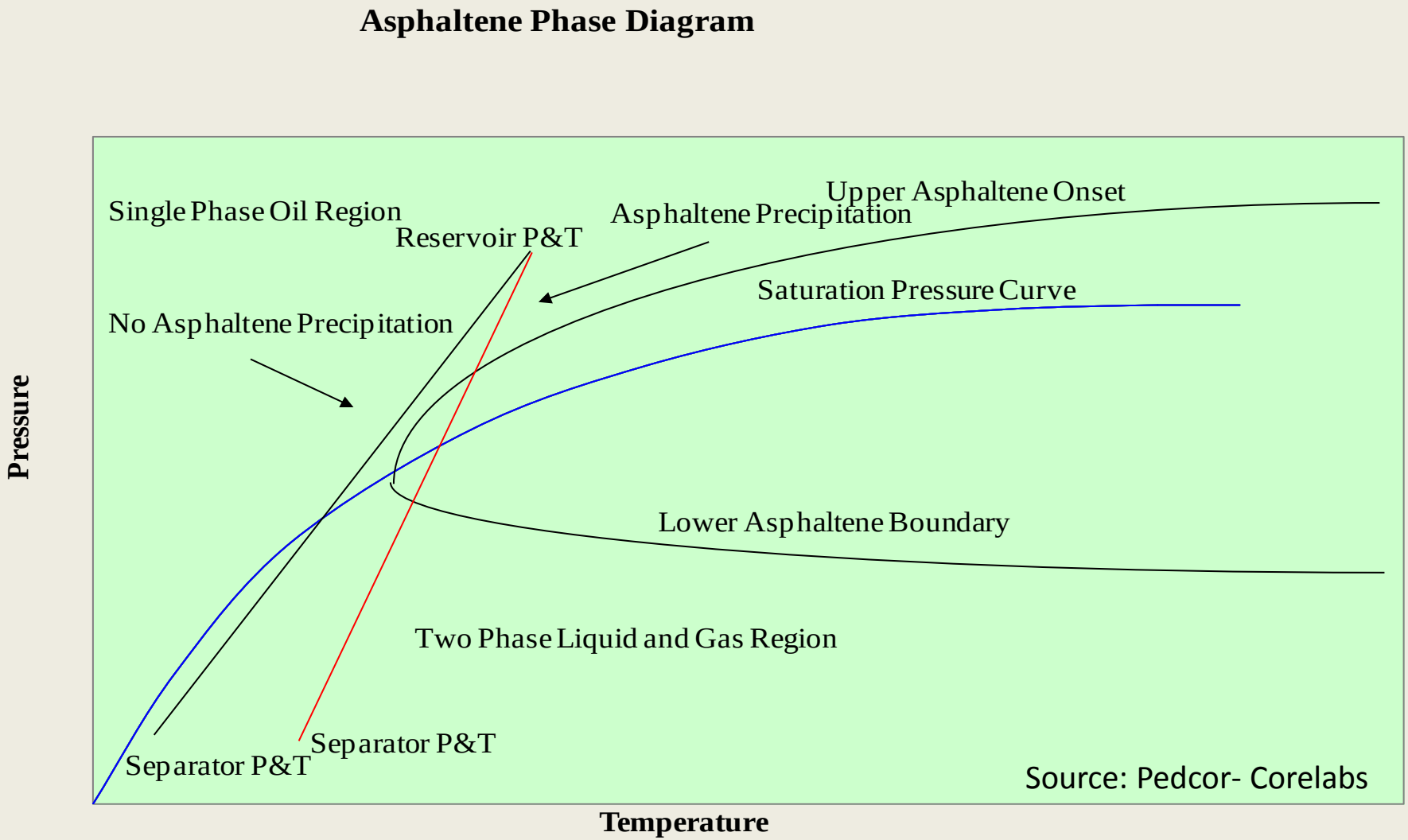
When the “steady-state” flow characteristics of the system are upset, asphaltenes may be precipitated out as sludges in the formation or on downhole equipment. These deposits are not significantly affected by diesel, gasoline, most paint thinners or soaps. Aromatic solvents such as xylene are the most effective solvents.

Asphaltenes seem to have a preference for precipitating out on bare metal surfaces. Surfaces that are already fouled with asphaltenes appear to attract asphaltenes more rapidly than very clean surfaces.

One of the most frequent precipitation sites for asphaltenes is just downstream of any mixing point where multiple crude streams come together.

Events that trigger heavy asphaltene precipitation include acid flowback, CO2 breakthrough, gas breakout, treatment with simple alcohols, and depressuring.

Precipitated Solids Filter Experiments



Although such testing is useful, it is only accurate when the conditions reflect actual well behavior.

World Wide Crude Oil Chemical Compositions (SARA)

Field	Asphaltene (Wt %)	Resin (Wt %)	Hydrocarbon			Number of Samples
			Aromatic (Wt %)	Saturated (Wt %)	Total (Wt %)	
Athabasca	23.3	28.6	32.1	15.9	48.1	15
Wabasca	21.6	30.6	32.1	15.6	47.7	7
Peace River	48.7	23.2	20.5	7.6	28.1	3
Cold Lake	20.6	28	30.5	20.9	51.4	7
E. Venezuela	12.6	32.4	36.4	18.6	55	5
Average on 46 Heavy Oils	22.9	30.6	30.4	16.1	46.5	46
PB HOT (EOA)	14.13	13.37	28.1	44.4	72.5	
PB HOT (WOA)	10.38	20.42	28.23	40.97	69.2	
W. Ven. (near HOT)	13.2	12.9	38	35.9	73.9	
Conventional Normal Oils	14.2		28.6	57.2	85.8	517
PBU Normal Oil	16.52 18.42	1.9	31.93	49.67	81.6	
Schrader Bluff	**4.9**	**29.0**	**24.7**	**41.5**	**66.2**	**15**

Information such as this published table of examples reflect the range of asphaltens in oils. The ratio of maltenes+resins to asphaltenes is a useful estimate of asphaltene precipitation behavior.

Asphaltene Removal

- Aromatic solvents and dispersants, but solubility is very low.
- Best solution? Keep them from precipitating. Determine what is causing the precipitation and work those issues.
- Removal options are poor.
- Cleaning the precipitation site as well as possible appears to slow reprecipitation.

Asphaltene Precipitation Mechanisms

- CO_2 (both from outgassing and acid shift of pH)
- Acid (both unspent and spent acid can have significant effects)
- pH (usually from CO_2, minerla or organic acid)
- Turbulence (mixing of crude oil streams are a major culprit)
- chemical shift that upsets micelle (loss of light ends, addition of siple alcohols and mutual solvents such as EGMBE)
- stored, static conditions, where oil becomes “dead” and allows the asphaltene platelets to aggregate (clump together). Stored crudes used as kill fluids often are major causes of asphaltene problems. Wash with xylene.

Additional Information

- A Production Chemist – sampling and testing.
- Selected References:

- R.K. Srivastava, R.K., Huang, S.S., Dong, Mingzhe: “Asphaltene Deposition During CO2 Flooding”, SPE Production and Facilities, Nov 1999.
- Trbovich, M.G., King, G.E.: “Asphaltene Deposit Removal: Long Lasting Treatment with a Cosolvent”, SPE 21038.
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- Rogel, E., Leon, O., Espidel, Y., Gonzalez, Y.: “Asphaltene Stability in Crude Oils”, SPE Production and Facilities, May 2001.
- Kokal, S., Al_dawood, N., Fontanilla, J., Al-Ghamdi, A., Nasr-El-Din, H., Al_Rufaie, Y.: “Productivity Decline in Oil Wells Related to Asphaltene Precipitation and Emulsion Blocks”, Production and Facilities, Nov. 2003.