Treatment Of Crude Oil Emulsions

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CONDITIONS FAVORABLE FOR EMULSION

An emulsion may be described as a combination of liquids whick will not molecularly disperse in each other. Oil field emulsions are created when the following conditions exist: (1) two liquids that are inmiscible, (2) presence of an emulsifying agent, (3) sufficient agitation to insure the liquids will properly mix. Natural emulsifying agents are present in crude oil. When crude oil emulsions are formed, steps must be taken to break them as insurance to the operator that the oil will meet pipeline specifications.

In water-in-oil emulsions, there are two properties that react in opposition to each other. They are interfacial tension and film toughness. Interfacial tension has the tendency to make the liquid form spheres when dispersed in another fluid because the particles take a shape that will give them the least possible surface area.

Film Toughness

In a water-oil emulsion, the production is moving through the system and as a result of this movement, the globules of water within the oil meet and come into direct contact with one another. If the film toughness of these droplets is weak, the two droplets will combine on contact and form a larger microscopic drop which will in turn bounce or collide into another droplet and combine. This process continues until the water droplet obtains the necessary weight where it will be heavier than the oil and will settle to the bottom.

When these droplets collide and are repelled or bounce apart it is commonly caused by film toughness. The transparent film surrounding the globule of water is strong enough to resist the force of being thrown into contact with another globule and prevents the two from forming a larger droplet. When this occurs, the droplets remain in suspension.

Film toughness is closely related to interfacial tension but they are two distinct properties. Interfacial tension is not affected by suspended particles, whereas film toughness is affected. For example, if two drops of clean water are placed on a perfectly clean surface they may be forced to combine by coming into contact with one another.

However, if minute particles of dust, iron sulfide, gilsonite or other foreign matter are sprinkled on the water or on the surface the two droplets may remain in constant contact for a long period of time before they combine. If the proper surfactant is added, it will water-wet the particles or foreign matter and they will move into the body of the drops and then the two drops will immediately combine.

Causes of Emulsion

The mechanics of a system often aid in forming an emulsion. One of the common causes is turbulance or agitation as the result of a restriction or gas coming out of solution. When a flowing well produces water it usually creates treating problems. Gas comes out of solution in the tubing, the fluid is forced through the choke with the gas at high pressure and generally causes very tight emulsions. A mechanically cut emulsion such as this is usually difficult to treat. The use of a bottom hole choke will usually minimize this type of emulsion. Under the hydrostatic head, gasses will not separate from the fluid; furthermore, elevated temperatures are good insurance against emulsions forming.

The pumping well can also create emulsions as the result of malfunction of the bottom hole pump. If the pump is leaking, the fluid is forced through small openings at a high velocity. The leak may be the result of wear or corrosion attacking the traveling valve, standing valve, plunger or the liners. Emulsions are also created when a well pumps off and the pump is pounding fluid. This may be remedied by decreasing the length of the pump stroke or by slowing down the pumping unit.

If an emulsion is being formed due to needed changes or adjustments in equipment, these changes should be exercised as quickly as possible for desired treating results at the most economical cost.

METHODS OF TREATING

When an emulsion of water-in-oil does not separate voluntarily, other measures must be applied. The desired results may be obtained with the use of chemicals, agitation, and settling time, or a combination thereof.

An emulsion breaker will penetrate the oil film encircling the droplet of water, decreasing the film toughness. When this occurs, the droplet of water may then coalesce with other droplets until the water droplet is large enough to settle through the oil as a result of its greater weight.

Caution should be exericsed when injecting emulsion breakers for two reasons: possibility of over treating and economy. When excessive amounts of some emulsion breakers are used, adverse affects are experienced; this overtreated oil is sometimes termed "burned oil". This is due to the change of interfacial tension to the point where oil droplets become dispersed in water and this reverse emulsion becomes dispersed into the crude oil.

The overtreated oil is easily identified by its peculiar light brown color. It has the appearance of dark clabbered milk or sometimes leaves perfectly clean oil with a clabbered sludge at the bottom. When you encounter this problem it may be remedied by rolling the tank with a neutralizing chemical. Chemicals that will readily overtreat are undesirable because constant chemical injection with the fluctuation in production invites overtreating conditions.

Economy is more important, as is evident throughout the oil industry today. The oil producer's margin of profit has been reduced over the years due to inflation and foreign oil, resulting in the reduction of allowables. The chemical supplier's engineer has the responsibility of selecting a demulsifier through laboratory tests that will most effectively and economically treat the emulsion. He should also recommend changes in treating systems and temperatures as necessary to enhance the recommended chemical. The oil company personnel should use the recommended procedures and report the results to the engineer on his scheduled visits, so adjustments can be made as conditions change.

Some operators have insured good service and reduced chemical costs by selecting several chemical suppliers to conduct laboratory tests and actual field tests. As a result, the treating efficiency and costs have been improved.

Some emulsions treat with chemical alone while others can be treated with heat alone. Some require both heat and

chemical. To obtain the desired results the chemical injection point should be as far ahead of the treater or treating vessel as possible because adequate agitation of the chemical with the emulsion is very important. Additional agitation is more important to some emulsions than others.

Lease production that is difficult to treat has been made easy by finding the well making the most severe emulsion and installing a chemical injector on that well. Investigation sometimes proves that on leases having individual chemical injectors at some of the wells, the injectors are placed on the wrong wells.

The proper operation of a treater or heater and gunbarrel combination is perhaps more important, in effectiveness and economy, than most other lease operations. Some feel that if emulsions will treat at 120°Farenheit, 160° will treat even better. By overheating it is possible to carry water to stock causing high shake-outs and high bottoms. Excessive heat will cook off solution gas and knock paraffin out of suspension causing paraffin tank bottoms that must be rolled, circulated or steamed. Excessive heat wastes gas, increases paraffin tank bottoms and accelerates scale and corrosion.

More important is the loss of gravity and shrinkage through elevated temperatures. The lighter ends, which are worth, as gasoline, approximately half as much as the oil, are knocked out of solution. As a result of loss in gravity, the oil decreases in sales value two cents per barrel for each degree decreased below 40° API gravity. These lighter ends may also be lost as the result of rolling a tank of oil or through thief hatches that fit improperly, etc. The average heater temperature in the Permian Basin should not exceed 130°. This can generally be attained through service of your chemical supplier's engineer. Certain crudes in some areas have been known to require 180° of temperature, however.

RELATED PROBLEMS

Iron sulphide, in relation to an emulsion, is one of the better emulsifying agents and is a major problem in some areas. When iron sulphide is present, the oil is more difficult to treat, paraffin problems are intensified and bad tank bottoms are predominate.

What is iron sulphide and where does it come from? I'm sure you have heard of "fool's gold". Iron sulfide is a precipitate or scale form of pyrite, which is commonly known as "fool's gold". It is dark gray or black in color.

There are two sources of iron in a producing well. Iron may be produced from the formation in the form of iron salts or from the pipe used in the production of the well. The pipe in the well is exposed to sulphide being produced with the oil or gas, which produces iron sulphide as a by-product of corrosion.

Even though iron sulphide is formed in water, it is preferentially oil-wet and will accumulate at the oil-water interface in the gun barrel or heater. If the interface is not bled off or chemically treated, it will eventually build up and carry to stock resulting in tank bottoms. A means of handling this problem has been developed. By actual field applications, it has been found that a surfactant will water-wet the particles of iron sulphide and put them in suspension in water. The iron sulphide will then be produced to the pit with the water from the treating vessel. The use of this type of chemical has been effective on tank bottoms containing iron sulphide, paraffin and emulsion.

Chemical applications of this type have also proved effective for iron sulphide removal in hydraulic lift systems by injection into the power oil. As a result, free type pumps have been in service twice as long without sticking.

CONCLUSION

I find it difficult to emphasize how important your part is in treating oil field emulsions. Carefully selected chemical usage as well as the amount of temperature used can mean dollars to your company. The proper combinations are not only the responsibility of your supplier but your experience and everyday contact with the problems can play a most important part.