Studying Degradation Rates of Polymeric Degradable Diverting Agents: A Case Study

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Abstract

There are many applications for hydrolytically degradable polymer in the oilfield industry, including fluid loss control, filter-cake removal, fluid diversion, etc. In a general way, the intended function of diverting agents is needed for a limited period. It is desirable that degradable materials be removed quickly so they do not have any effect on the final fluid flow.

One of most favorite applications of these degradable materials is where it is coupled with viscoelastic surfactant in the multi-zone reservoirs with high contrast in permeability in order to create a uniform distribution of stimulation fluids across different zones.

In this study, various tests were conducted to investigate the degrading time of fiber, i.e. hydrolytically degradable polymers. Three commercial fibers evaluated under different parameters such as various temperatures, pressures, effect of salts, and solvents. The goal of this research was to determine effect of each parameters and optimum conditions for each one in case of applicability.

Introduction

In this paper, study of hydrolytically degradable polymers, and evaluation of their degradation time and effect of some chemical on this parameter were described. The polymer tested during our experiments, have different crystallinities and composition of chemicals. Experimental works that have tried to evaluate polymer degradation can be categorized into two main groups. In the first category, effect of different degradation accelerators on different polymer is tested. Some other research, took a constructive step to fabricate a setup in order to evaluate bridging ability of fiber assisted stimulation stages (Potpoenko et al, 2009).

In this work, we tried to apply best experimental procedure to determine degradation time of some available commercial fibers. The application of this novel diversion system is a gas reservoir with huge contrast in permeability in different producing intervals in south of Iran.
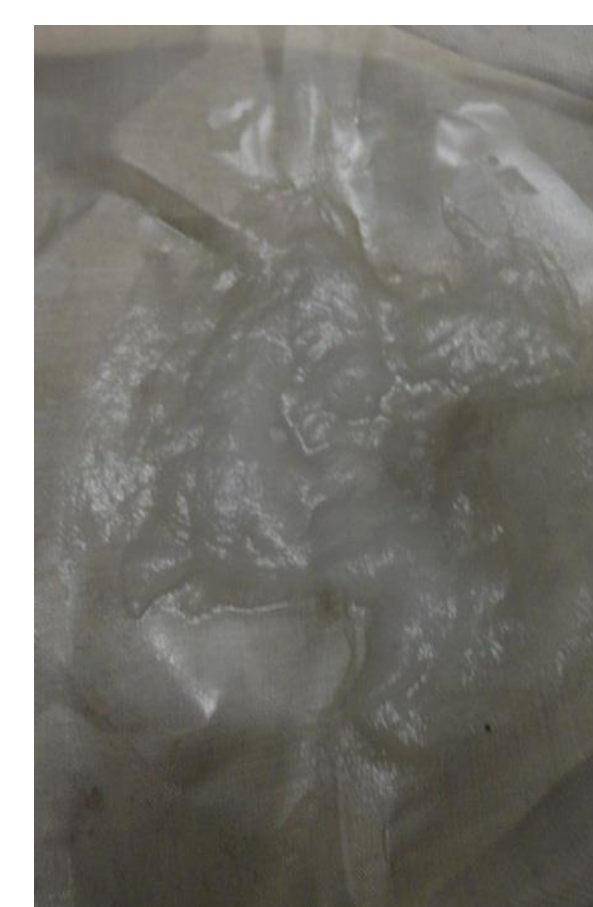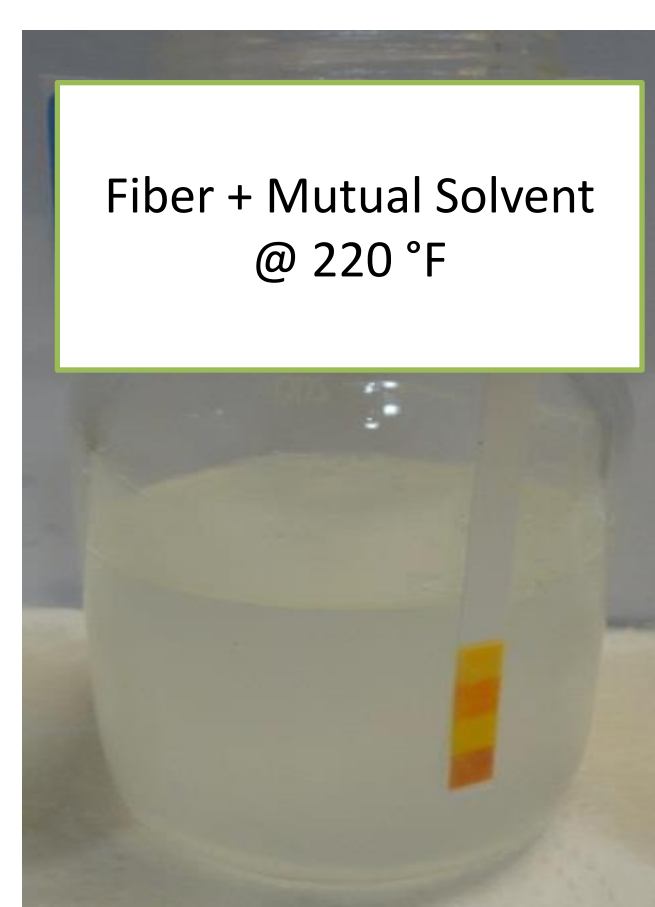
Experimental Procedure:

To determine the degradation time of fibers, a known amount of fiber was dissolved in 20% CaCl2 solution, the solutions were heated to specified temperature between 6 to 24 hours. Temperature was varied from 93 °C to 135 °C. The tests also were performed in presence of mutual solvent and 20% CaCl2 solution to check their effect on polymer degradation rate. After predefined time in each tests, solution was passed through 100-mesh sieve and remained residue was dried at oven and finally its weight was measured.

Applied Recipe during the degradation tests

Name	/1000cc	LAB unit
Fresh Water	700	cc
CaCl$_2$	200	gr
Mutual Solvent	100	Cc
Fiber	75	lb

Results and Discussions

The fibrous component, which degrades as a function of temperature and time also requires the presence of solvents and the small amount of salts to degrade completely.

Figure 1 shows a fiber solution during one of our tests right after mixing (Fig 1.a) and its conditions after passing from 100-sieve mesh (Fig 1.b). As could be seen, a thick film remained on the solution that could be interpreted as bridging ability while pumping in porous media.

In figure 2 dried residue after polymer degradation in two different tests are shown. As could be seen in Fig 2.a, polymer structure is deformed and some of initial value is hydrolyzed. The same test without mutual solvent is repeated and polymer condition after drying in oven is

shown in Fig 2.b. It is clear that rate of polymer degradation in this case is lower and polymer structure is mainly kept as its initial conditions.

Figure1: fiber in 10% mutual solvent (left) - fiber after filtering on 100-mesh sieve (right)
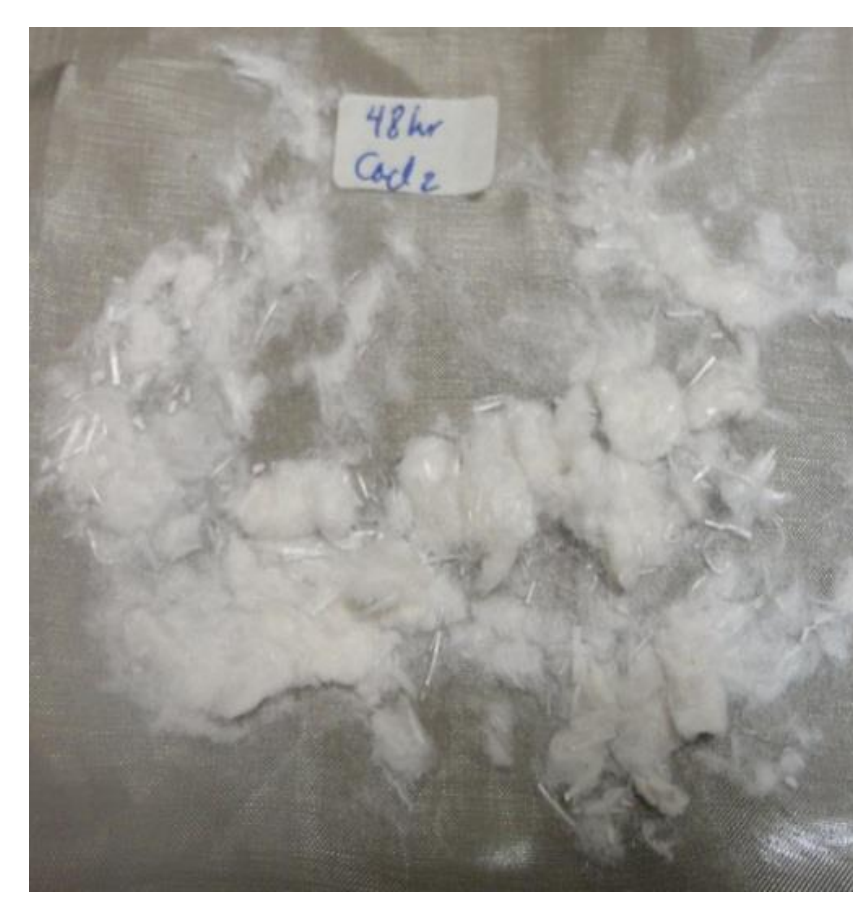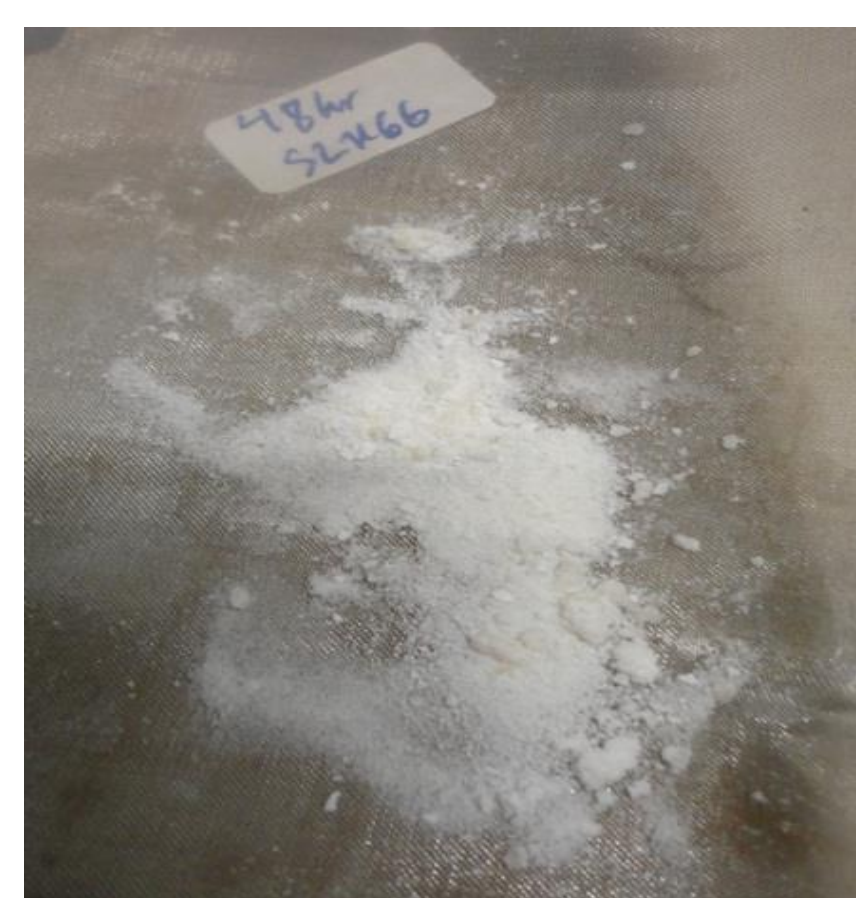

Figure 2: fiber in 10% mutual solvent + 20% CaCl2 after drying in oven (left) and fiber in 20% CaCl2 after drying in oven (right)

Conclusions

The most indispensable outputs of this study could be summarized as follows:

1. Mutual solvent and CaCl2 acted as degradation accelerator in all cases. It seems that this additive helps to hydrolyze the structure of three available polymers.
2. Pressure has no clear effect on degradation rate of polymer (generally aliphatic polyesters).
3. It seems that hydrolyze process for each polymer has a temperature threshold that in cases lower than it, no degradation happens even in case of lasting test for a long period. After passing this threshold, degradation will increase from 0% to 100% in a noticeable short time.

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