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Instant Linear Gel Preparation for Coal Bed Methane Gas Operations

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ABSTRACT

In earlier article we prepared fracturing linear gel with fossil diesel, bio-diesel and also used suspending, anti-settling agents and emulsifiers. But through this research a novel and an efficient method for the preparation of linear gel direct mix with water, guar gum and sodium acetate together instantly. In this instead of diesel we used water and no need to mix anti settling agents, suspending agents, emulsifiers that resulted as 30 viscosity linear gel. Ammonium per sulphate or Ammonium peroxydisulphate and enzyme-G used for oxidation purpose to break the gel gradually at particular static temperature. Degradation pattern observed from the breaker test showed that reduction in gel viscosity depends on time, temperature & breaker concentration. Observations from experiments revealed that small concentration of breaker provides rapid break compared to oxidative breakers. This article, designing of fracturing fluids describes how to use the fluids viscosity generated by the gelling agents like guar gum for CBM operations.

Highlights:

- Fracturing fluid is roughly 99% water but also contains numerous chemical additives as well as propping agents, such as sands, that are used to keep fractures open once they are produced under pressure.
- The Linear gel preparation hydrated with water and guar gum, observed their properties in different temperatures.
- In frac operation With Fossil diesel and bio-diesel has many draw backs that way we tried with only water and guar gum used and it is eco-friendly and economically less for Frac operations.

Keywords: Breakers; CBM operation; Fragmentation; Linear gel; Viscosity properties.

INTRODUCTION

Hydraulic fracturing typically involves millions of gallons of fluid that are pumped into oil or gas well at high pressure to create fractures in the rock formation that allow oil or gas to flow from the fractures to the wellbore [1]. The main functions of fracturing fluids are to open the fracture and to transport propping agents along the length of the fracture. They are four types of fracturing i.e. water fracturing, gelled fluids, linear gels, crosslink gels [2]. The chemistry of commonly used fracturing fluids and additives are guar

[Figure 1]. Guar has along polymer chain and high molecular weight [Figure 2]. Gymer composed of Mannose and galactose sugars have high affinity for water. When the powder added to water, the guar particles swell and hydrate, which means the polymer molecules become associated with many water molecules and unfold and extend out into the solution which tends to overlap and hinder motion, which elevator the viscosity of the solution [3].The guar polymer has chemicals added to the fracturing fluids include friction reducers, surfactants, gelling agents (guar gum), scale inhibitors, acids, corrosion inhibitors, antibacterial agents. Depending on the site, 15-80 % of the fracturing fluid injected is recovered as flow back water at the well head. Biocides/Bactericides are added to minimize the enzymatic attack of the polymers used to gel the fracturing fluid by aerobic bacteria present in the base water [4]. Agro material while preparation of frac concentration should be in basic nature. So we can use Sodium bicarbonate or sodium acetate is mixed in the concentration to maintain the pH. Usually the gelling agents in fracturing fluids are guar gum derivatives such as hydroxyl propyl guar and carboxy methyl hydroxyl propyl guar (or) cellulose derivatives such as carboxyl methyl guar, hydroxyl ethyl cellulose, hydroxy propyl cellulose, xanthangum [5]. Before stating frac operation need to add biocide (anti-bacterial agent in water tanks, it will control the growth of micro-organisms will quickly degrade the polymer to a non-functional level. So the addition of biocides and bactericides to fracturing fluids will prevent the introduction of anaerobic sulfate reducing bacteria (SRB) into the reservoir [6].Guar galactomannan is a plant polysaccharide with extensive applications in food, paper, and textile and petroleum industries [7]. The main advantages of using guar are its low cost, easy availability and capacity to form viscous solutions and gels at low concentration. Additionally, chain architecture of guar galactomannan can be selectively modified to tailor properties of guar formulations and open up new opportunities for guar usage [8]. In many types of shale, proppant conductivity drops considerably in the presence of water because the rock-fluid interactions soften the rock leading to proppant embedment [9]. The fracturing treatments require a higher viscosity fluid, such as linear fracturing fluids [10]. These are formulated by adding a wide array of different polymers to water [11]. Such polymers are dry powders that swell when mixed with an aqueous solution and form a viscous gel [12]. The gel-like fluid is then more able to transport the proppant than a normal low viscous (slick water) fluid [13]. Common polymer sources used with the linear gels are guar, Hydroxypropyl Guar (HPG), Hydroxyethyl Cellulose (HEC), Carboxymethyl hydroxypropyl guar (CMHPG), and Carboxymethyl Hydroxyethyl cellulose (CMHEC) (EPA 2004). In low permeability formations, linear gels control fluid loss very well, whereas in higher permeability formations fluid loss can be excessive. Linear gels tend to form thick filter cakes on the face of lower-permeability formations [14]. So this study provides focuses the way to mix the fracturing fluid, how Linear gel hydrating and how to perform breaker test.

In general, a fracturing fluid can be thought as the sum of three main components:
Fracturing Fluid = Base Fluid + Additives + Proppant

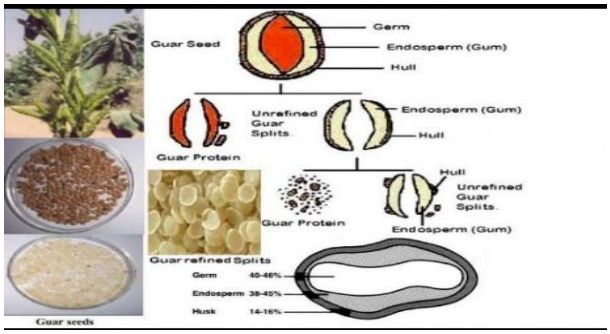

Figure.1 Guar Seed

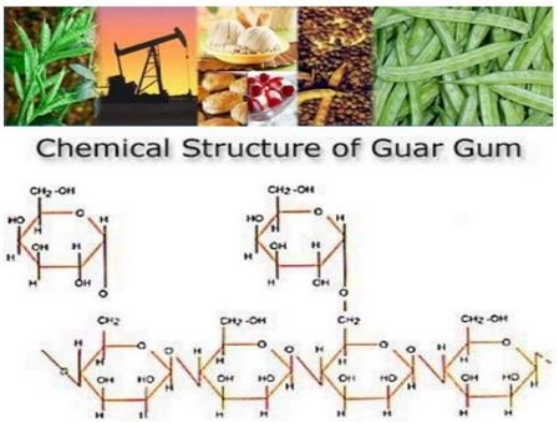

Figure.2 Chemical structure of guar gum

MATERIALS AND METHODS

Experimental Studies:

- Production water
- Sodium bicarbonate or sodium acetate as a buffering agent.
- Guar gum powder [Figure 3].
- Two breakers, Ammonium per Sulphate which is in solid state and another one is liquid Hemicellulase enzyme-G.
- Gas flow which is in liquid state (composition of Methanol 2-Butoxyethanol Ethylene oxide nonylphenol polymer Alcohols, C12-16, ethoxylated Tridecyl alcohol Nonylphenol Ethoxylated nonionic surfactant).It will flow back after fracturing.
- Biocide is a composition formed from ingredients comprising peroxide and a hypochlorite.
- 20/40 size proppant.

Figure.3 Guar gum powder

RESULTS AND DISCUSSION

Water Analysis: Usually for every linear gel testing we should check water quality because parameters of water will affect more during formation of gel Hydration. If water has more pH, hardness, chlorides, iron leads to gel break very quickly. The following parameters should check before testing as shown in table 1.The water should be color less, the turbidity of water should be low and the pH value should be 6-8. The chloride is determined by titration methods or chloride strips. The chlorides should be in the range up to <800 ppm. Iron can check by using electronic instrument. Iron should be range up to <10 ppm. Hardness can check by titration method and it should be in the range up to <100 ppm. Bicarbonate should be range <1000 ppm. Sulfates should be range <300 ppm. TDS should be range < 50,000 ppm. Reducing agent should be negative. Bacteria should be range <800,000. Specific Gravity of water can be determined by Hygrometer. Biocide should be added in water sample before testing to kill any bacteria.

Table 1:Test1 (Sample Water)

Parameters	**Measured values**
Clarity, color, odor	Clear
Sample temperature, °C	26
Specific gravity	1
Initial pH	7.5
Iron (Fe^{2+}/Fe^{3+}) ppm	1
Chloride, ppm	400
Total Hardness ,ppm	80
Bicarbonate ,ppm	800
Sulfates ,ppm	200
TDS ,ppm	30,000
Reducing Agent	Negative
Bacteria	500,000

Viscosity Measurement: A direct viscosity reading in centipoises (cp) was obtained by taking the 300 rpm reading of VG meter with Rheometer (FI spring, BI bob and Rotor). The viscosity of gel was measured when the gel exhibit stringy and pourable behavior. So the apparent viscosity of gel was determined using the Fann 35 Rheometer.

Procedure for preparation of 1000 mL gel Hydration: Take 309 mL production water into Blender ought to look after velocity (1900-2000 rpm). Add 60 g of Buffering agent like sodium hydroxide (or) sodium Bicarbonate (or) sodium acetate which should be in powder state, mix until the material is dispersed and lump free for 15 min. After mixing the buffering agent, the slurry should be maintained in basic nature [Figure 4]. Need to check the basic nature by placing a pH strip into the slurry. Now add 240g of guar gum and continue the mixing for 20 min (or) until the concentration of slurry is smooth and lump free. Measure the density of the slurry. If the density of the slurry varies more than 0.1 ppg, refer to "cut back (or) weight-up" charts to correct the slurry density. Measure the viscosity of the slurry, it should be maintained at 30-32viscosity in order to pump the slurry.

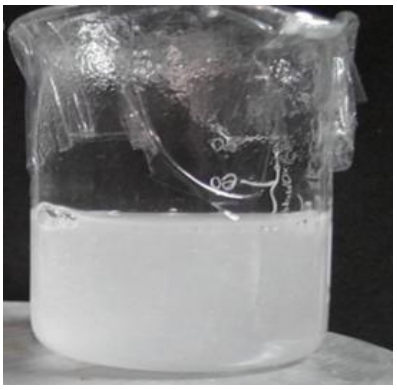

Figure.4 Instant linear gel

Breaker Test

Unit conversions:

$$1ppt = \frac{1pound}{(1000 \times 1gallon)} = \frac{1 \times 453.2}{(1000 \times 1 \times 3.782)} = \frac{453.2}{3782} = 0.12gms/lit$$

Where 453.2 g is a factor, 1 gallon=3.782L

$$1gpt = \frac{1gallon}{1000gallons} = \frac{1ltr}{1000ltr} = \frac{1ml}{1000ml}$$

Now add 1ppt ammonium persulpate and 1gpt Enzyme-G into linear Gel glass bottle and mix it well. Put it in water baths which are maintaining at 60ºC and 45ºC temperature, now check the Viscosity for every 10 min.

Fragmentation Reaction:

Fragmentation

X–Y → X + Y

X-Y *fragments* to X and Y

Initially the gel viscosity is 30, under the gas well the bottom hole circulating temperature is 45ºCand 60ºC, by using 1ppt ammonium persulpate and 1gpt Enzyme-G breaker concentrations the fragmentation takes place, it means the gel viscosity will break gradually based on these temperatures and breaker concentration. If we want to break the gel viscosity very quickly we can increase the breakers concentration.

In Table.2 we observed for every 10 min gel breaks gradually up to 180 min. usually the slurry pumping time is near to 30 min approximately. So in hydro frac operation the gel carries 20-40 size sand, breaker's, and gas flow solution injected into well under high pressure forms fissures. After slurry pumped (i.e., after 30 min) the fragmentation reaction takes place, the breakers acts on gel under bottom hole circulating temperature, 30 viscosity linear gel becomes watery gradually [Figure 5]. After 180 minutes the gel totally will break and become water, the gas flow will return back as flow back water. This flow back water again we can use for production water after reverse osmosis process.

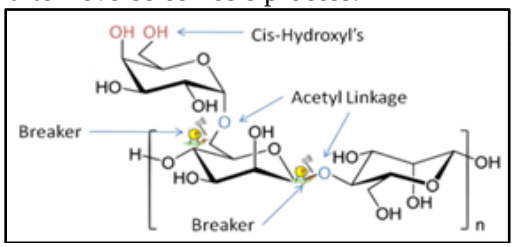

Figure.5 Mechanism of Breaker test

Table 2: Test-2 Breaker Test Result (7.5gpt gel under breaker concentration at 1ppt oxidizer and 1gpt Enzyme-G)

S. No	Gel Breaking Time (minutes)	Linear gel viscosity 1 ppt and 1 gpt breakers	
		60°C	45°C
1	0	30	30
2	10	27	28

3	20	25	26
4	30	23	24
5	40	20	21
6	50	17	19
7	60	15	17
8	90	11	14
9	120	8	10
10	150	5	7
11	180	0	2

APPLICATIONS

Present work is totally eco-friendly; the linear gel can also keep continuously in hydration tanks for 22 h. So, we can pump directly into well with high pressure and the used chemicals are very less hazardous. No smoke point for this linear gel because the gel prepared with water. When compared with hydro carbons diesel liner gel this water gel has many advantages in all aspects and worth less for extreme operations.

CONCLUSIONS

The main focus of this research was to avoid the pollution in extreme operations, because of frac operation environment should be eco-friendly and naturally. The first objective of this research was the instead of hydro carbons diesel, we used water for the preparation of linear gel. This is direct mixing method; this linear gel effectively works in frac CBM onshore and off shore operations. Here less quantity of oxidizing agents (breakers) consumption take place. The main benefit is economically very less for frac operations.

We conclude from the above experiment that without using any hazardous chemicals for preparation of linear gel observed good viscosity properties at bottom hole static temperature. This experiment is totally eco-friendly; the linear gel can also keep continuously in hydration tanks for 22 h. So we can pump directly into well with high pressure and the used chemicals are very less hazardous. No smoke point for this linear gel because the gel prepared with water. So when compared with hydro carbons diesel liner gel this water gel has many advantages in all aspects and worth less for extreme operations.

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