Plum Tree Gums as Local Alternatives for Foreign Drilling Fluid Materials

Dr. Faleh H.M. Almahdawi*, Dr. Mohammad N. Hussain**

Haider Salim Jasim***

*University of Baghdad, College of Engineering, **Ministry of Oil /PRDC, ***Iraqi Drilling Company.

Abstract:

A few years ago oil well drilling cost increased due to using modern technique such as equipment and materials that are used by specialist companies so studies and researches were required to decrease these costs. In this study we tried to find local alternatives for foreign drilling fluid materials that are aimed to decrease oil well drilling cost although the cost of drilling fluid materials reach to 30 % of total materials cost of drilling oil well.

In the first part of this study seven local materials and it's tested under API Specification 13A for Drilling Fluids Materials were investigated. Plum Tree Gum was succeeded in this test among several other materials as drilling fluid materials. The second part of this study was a comparison between these local alternative and similar foreign materials for same sample to show physical and rheological properties. The third part of this study was tested this local alternative under different values temperature to show effect the temperature on physical and rheological properties of this local alternative. The results approved that; Plum Tree Gum, local alternative, can use as filtration control materials for water based drilling fluid. Also this local alternative increased viscosity as minimal for water based drilling fluids, So it can be used as part alternative for Bentonite to increase viscosity by increasing Yield point and decreasing solids concentration in drilling fluids so it has positive effect on Rig equipment's and Pay-zone.

Plum Tree Gum is Ore polymers (plant origin)

Keywords: drilling mud, API Specification 13A, rheological properties, Temperature Effect, local alternative, Filtration, Viscosity, Gum

الخلاصــــة :

خلال السنوات القليلة الماضية لقد ازدادت كلف حفر الابار النفطية نتيجة استخدام التقنية الحديثة من المعدات والمواد من قبل الشركات المختصة لذا اصبحت الحاجة ضرورية الى اعداد دراسات وبحوث لتقليل هذه الكلف ومن هذه الدراسات هو ايجاد بدائل محلية لمواد سوائل الحفر الاجنبية المستخدمة حاليا في الحقول النفطية (علما ان كلفة مواد سوائل الحفر تصل الى ٣٠ % من الكلفة الكلية للمواد المصروفة على حفر البئر النفطي .

في الجزء الاول من هذا البحث تم تهيئة سبعة بدائل محلية وفحصها حسب الفحوصات القياسية العالمية API Specification 13A for Drilling Fluids Materials ولقد اثبتت التجارب نجاح هذا البديل المحلي من بين عدة بدائل اخرى .

في الجزء الثاني تم مقارنة هذه البدائل الناجحة مع اقرانها من المواد الاجنبية وذلك بإضافتها بتراكيز وزنية مختلفة لنفس النموذج من سائل الحفر لبيان الخواص الفيزيائية والريولوجية لسائل الحفر .

في الجزء الثالث من البحث تم اجراء فحوصات عند درجات حرارة مختلفة لبيان تأثيرها على الخواص الريولوجية والفيزيائية للبدائل الناجحة علما ان الفحوصات اعلاه تم تنفيذها في مختبرات مركز البحث والتطوير النفطي.

اثبتت النتائج ان البدائل المحلية :

١- يمكن استخدامها كمواد مقللة للراشح وتؤدي الى زيادة لزوجة سوائل الحفر المائية القاعدة نسبيا .
٢- يمكن استخدامها كبديل جزئي للبنتونايت حيث انها تؤدي الى زيادة اللزوجة عن طريق نقطة المطاوعة وبالتالي تقليل نسبة الاجزاء الصلبة في السائل وهو عمل ايجابي للحفاظ على معدات جهاز الحفر والمكامن المنتجة

البدائل المحلية هي مواد اولية وهي عبارة عن بوليمرات من اصل نباتي وهي :

صمغ اشجار فاكهة الالو.

Introduction:

1-PLUM TREE GUMS:

Fig. (1) Plum Tree Gum.

Natural gums are polysaccharides of natural source in figure (1), adept of producing a large increase in a solution's viscosity, even at small absorptions. In the food industry they are used as thickening agents, emulsifying agents, gelling agents and stabilizers. In other, flocculating agents, swelling agents, clarifying agents, encapsulating agents, foam stabilizers, etc. [1-3].

Most often these gums are found in the woody elements of plants or in seed coatings.

Natural gums can be branded according to their origin. They can also be categorized as uncharged or ionic polymers (polyelectrolytes). Examples include

- Natural gums found from seaweeds:
    - Polyelectrolytes:
        - Agar
        - Alginic acid and Sodium alginate
        - Carrageenan
- Natural gums obtained from non-marine botanical means :
    - Polyelectrolytes:
        - Gum arabic , from the sap of Acacia trees
        - Gum ghatti, from the sap of Anogeissus trees
        - Gum tragacanth , from the sap of Astragalus shrubs
        - Karaya gum , from the sap of Sterculia trees

- Uncharged:
    - Guar gum , from guar beans
    - Locust bean gum , from the seeds of the carob tree
    - Beta-glucan, from oat or barley bran
    - Chicle gum, an older base for chewing gum obtained from the chicle tree
    - Dammar gum, from the sap of Dipterocarpaceae trees
    - Glucomannan , from the konjac plant
    - Mastic gum, a chewing gum from ancient Greece obtained from the mastic tree
    - Psyllium seed husks, from the Plantago plant
    - Spruce gum, a chewing gum of American Indians obtained from spruce trees
    - Tara gum , from the seeds of the tara tree
- Natural gums created by bacterial fermentation:
    - Polyelectrolytes:
        - Gellan gum
    - Uncharged:
        - Xanthan gum

Amylose is a linear polymer of glucose mainly linked with α (1→4) bonds. It can be made of several thousands of glucose units. It is one of the two components of starch, the other being amylopectin.

Polysaccharides are polymeric carbohydrate molecules composed of long chains of monosaccharide units bound together by glycosidic linkages and on hydrolysis give the constituent monosaccharides or oligosaccharides. They range in structure from linear to highly divide. Examples include storage polysaccharides such as starch and glycogen, and structural polysaccharides such as cellulose and chitin. Polysaccharides are often quite heterogeneous, containing slight reforms of the repeating unit.

Humans have settled some of these polysaccharides into useful yields, including xanthan gum, dextran, gellan gum, diutan gum welan gum and pullulan. Most of these polysaccharides exhibit useful visco-elastic properties when thawed in water at very little levels.

2-POLY-SAL HT

POLY-SAL* HT additive is a top-quality, preserved polysaccharide castoff to provide filter control and rheology constancy in all kindes of water-base muds This non-ionic, normal polymer is active in all greasepaint waters, including top-salinity and top-hardness brines for example KCl,NaCl, MgCl2 and compound brines.[4].

- Typical Physical Properties

Physical appearance.. Off-white powder

Specific gravity... 1.5

pH (1% solution) .... 4 - 7

Solubility in water ....Soluble

bulk density 19-44 lb/ft3 (300-700 kg/m3)

POLY-SAL HT polymer is intended to decrease fluid loss and rise viscosity in all water-base drilling fluids. It is specially applicable and inexpensive in brine and saturated-salt schemes where other crops are not real. This comprises clear brines castoff for workover and completion processes POLY-SAL HT additive encapsulates elements with a protective polymer covering to function as a defensive colloid. It is actual as a mud stabilizer in addition to a fluid-loss reducer when drilling vanish formations such as salt or anhydrite and when drilling hydra table shales POLY-SAL HT starch covers a preservative; though, it is recommended to treat dynamic system be treated by additional biocide, especially if the mud system has a little salinity In low pH, low salinity and freshwater requests, the system should be checked for the attendance of bacteria and preserved by an appropriate biocide if a difficulty develops.

- **Advantages**

-An economical, one-sack, conserved product for viscosity and filter control

-Active in a wide series of make-up waters, counting high- hardness brines, high- salinity

-Purposes in NaCl, KCl, MgCl2, CaCl2 and multifaceted brines

-Achieves satisfactorily over a varied pH range

-Minimizes filtration harm to production zones

-Pre-gelatinized for big efficiency

-Delivers wellbore constancy through filter control and encapsulation

- **Limitations**

-POLY-SAL HT preservative rapidly damages when exposed to temperatures in extra of 275°F (135°C)

-Can need the adding of a biocide

-Less active in top-pH/top-calcium, saturated brine systems

-could not be castoff in zinc brines

Experimental work:

PLUM TREE GUM TEST UNDER API SPECIFICATIONS 13A:

Physical specifications of Plum tree gum were tested under API Specification 13A. In the beginning this material was tested under CMC – LVT physical specifications in order to test the Plum tree gum as Filter-loss-control material like CMC and this test showed that Plum tree gum is behave near from CMC –LVT in physical specifications as filter loss control , as shown in table (1) .

.Table (1) CMC – LVT Physical Specifications Test of Plum Tree Gum.

Requirement	Standard	Result
Starch or starch derivates presence	No	Yes
Solution properties		
Viscometer dial reading at 600 r/min	Minimum 90	9
Filtrate volume , millilitres	Maximum 10	16

Then it tested as CMC – HVT physical specifications to see if the Plum tree gum can increase the viscosity in minimal. We get good results, as shown in table (2).

Table (2) CMC – HVT Physical Specifications Test of Plum Tree Gum.

Requirement	Standard	Result
Starch or starch derivates presence	No	Yes
Solution properties		
Viscometer dial reading at 600 r/min		
- In deionized water	Minimum 30	84
- In 40 g/l salt solution	Minimum 30	8
- In saturated salt water	Minimum 30	7
- Filtrate volume , millilitres	Maximum 10	16

After that the local material was tested as Starch physical specifications. The test results confirmed that Plum tree gum (local material) is a good Filter-loss-control agent in salt and salt saturated water, as shown below in table (3).

Table (3) Starch Physical Specifications Test of Plum Tree Gum.

Requirement	Standard	Result
Suspension properties		
Viscometer dial reading at 600 r/min		
- In 40 g/l salt water	Maximum 18	36
- In saturated salt water	Maximum 20	13

Filtrate volume		
- In 40 g/l salt water, milliliters	Maximum 10	8.8
- In saturated salt water, milliliters	Maximum 10	9.6
Residue greater than 2000 µm	No residue	

Note The Principles, Procedures, Reagents and Apparatuses of all above tests you can see in reference [5].

Comparison between local and foreign material:

For comparison between local materials (Plum tree gum) and foreign material (Poly-Sal HT). we prepared blank sample and Tested the Rheological Properties after addition same concentration of both materials , the results tabulated in tables (4, 5) .

Table (4) Properties of Samples prepared by Fresh Water Bentonite and Plum Tree Gum.

Rheological Properties	Blank	0.5 gm	1 gm	1.5 gm	2 gm	2.5 gm	3 gm
R600/R300	38/33	61/60	78/73	86/81	88/83	120/114	140/130
R200/R100	30/27	58/56	71/69	79/75	78/74	112/106	125/115
R60/R30	26/25	55/54	67/65	72/67	71/68	97/95	111/106
R6/R3	24/24	51/50	60/60	65/62	63/57	88/85	99/95
AV	19	30.5	39	43	44	60	70
PV	5	1	5	5	5	6	10

YP	**28**	**59**	**68**	**76**	**78**	**108**	**120**
YP/PV	**5.6**	**59**	**13.6**	**15.2**	**9**	**18**	**12**
10sec/10min Gel	**27/33**	**45/47**	**52/56**	**54/61**	**52/59**	**69/77**	**76/87**
Mud Weight	**1.03**	**1.03**	**1.03**	**1.03**	**1.03**	**1.03**	**1.03**
API Fluid Loss	**17.6**	**14**	**12.4**	**10.4**	**10.4**	**10**	**9.2**
PH	**9.7**	**9**	**9**	**9.4**	**8.9**	**8.9**	**8.7**

Note *1- Blank it is - A drilling fluid sample without weight concentration, also base sample for all Local and Foreign Materials tests*

- consist of (350 cc Tap Water + 20 gm Bentonite + 0.1 gm Sodium Hydroxide)

2- All above tests in laboratory room temperature

Table (5) Properties of Samples prepared by Fresh Water Bentonite and Foreign Material (PolySal HT).

Rheological Properties	Blank	0.5 gm	1 gm	1.5 gm	2 gm	2.5 gm	3 gm
R600/R300	**38/33**	**48/42**	**50/45**	**52/48**	**48/42**	**54/46**	**62/56**
R200/R100	**30/27**	**41/38**	**44/41**	**47/44**	**41/37**	**45/41**	**52/47**
R60/R30	**26/25**	**37/35**	**40/39**	**43/42**	**36/35**	**40/39**	**45/44**
R6/R3	**24/24**	**34/34**	**37/37**	**39/39**	**32/32**	**37/37**	**41/41**
AV	**19**	**24**	**25**	**26**	**24**	**27**	**31**
PV	**5**	**6**	**5**	**4**	**6**	**8**	**6**

YP	28	36	40	44	36	38	50
YP/PV	5.6	6	8	11	6	4.7	8.3
10sec/10min Gel	27/33	34/37	36/41	38/44	33/40	37/45	43/52
Mud Weight	1.03	1.03	1.03	1.03	1.03	1.03	1.03
API Fluid Loss	17.6	14.4	13.2	10.2	9.2	8.8	8.4
PH	9.7	9.5	9.3	9.2	9.8	9.5	9.4

Note 1- All above tests in laboratory room temperature

2- (R600,R300,R200,R100.R6,R3,10secGEL and10minGEL), these readings measured by 8-Speed Electronic Viscometer[6]

3-Mud Weight measured by Mud Balance [6]

4-API Fluid Loss measured by Low Pressure Filter Press [6]

5-PH measured by PH Meter[6]

Table (6) Test Rheological Properties for Fresh water bentonite (blank sample) with adding Local Material, Plum Tree Gum (Filter-loss-control Agent) as different temperature.

Rheological Properties	Lab. ° C	40 ° C	50 ° C	60 ° C	70 ° C
R600/R300	95/87	87/76	85/75	85/75	85/75
R200/R100	84/79	71/67	70/65	75/70	75/70
R60/R30	73/70	63/59	63/60	66/65	69/69
R6/R3	63/60	55/52	57/55	63/62	67/66
AV	47.5	43.5	42.5	42.5	42.5
PV	8	11	10	10	10

YP	**79**	**65**	**65**	**65**	**65**
YP/PV	**9.9**	**5.9**	**6.5**	**6.5**	**6.5**
10sec/10min Gel	**55/65**	**49/59**	**54/60**	**55/63**	**57/65**
Mud Weight	**1.03**	**1.03**	**1.03**	**1.03**	**1.03**
Filter Fluid Loss	**10.0**	**10.4**	**10.8**	**11.6**	**11.6**
PH	**9.3**	**9.2**	**9.2**	**9.1**	**9.1**

Note -Add 2 gm of Plum Tree Gum to blank sample
-Prepare five blank sample and heating blank samples by using Thermo Cup[6]
- Each blank tested for definite temperature.

The result of tables was plotted as shown in figures (2-6) below:

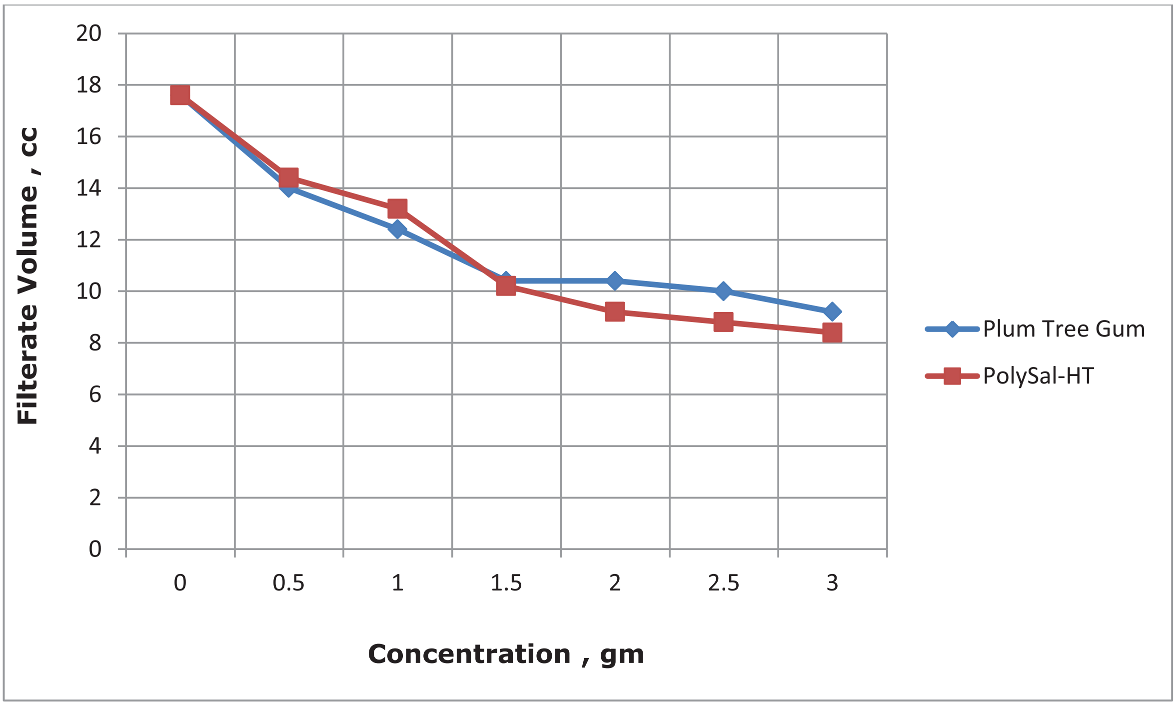

Fig. (2) Effect of additives concentrations on Filter Volume property for Plum Tree Gum and PolySal-HT.

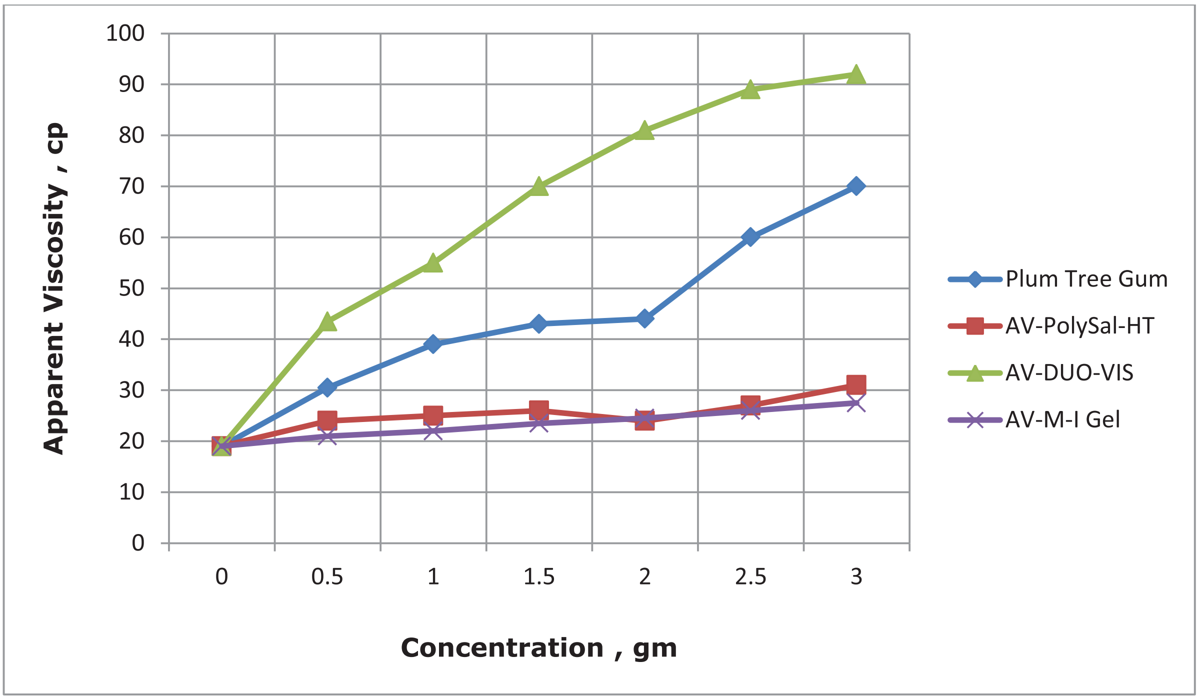

Fig. (3) Effect of additives concentrations on Apparent Viscosity (AV) for Plum TreeGum, PolySal-HT, DUO-VIS and M-I Gel.

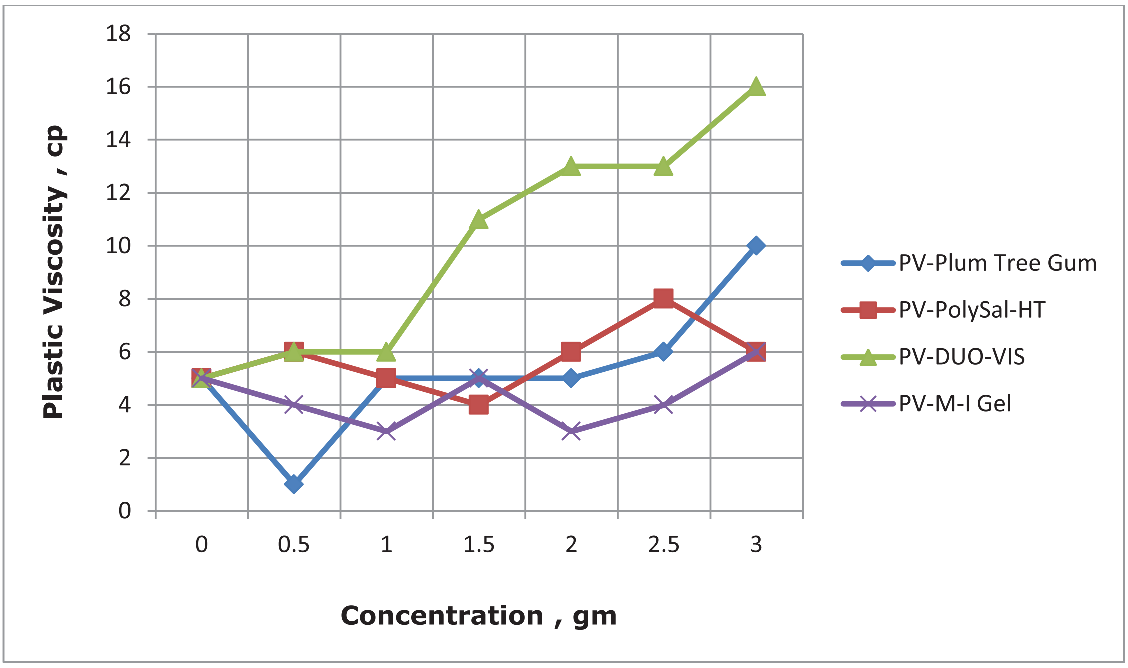

Fig. (4) Effect of additives concentrations on plastic Viscosity (PV) for Plum Tree G um, PolySal-HT, DUO-VIS and M-I Gel.

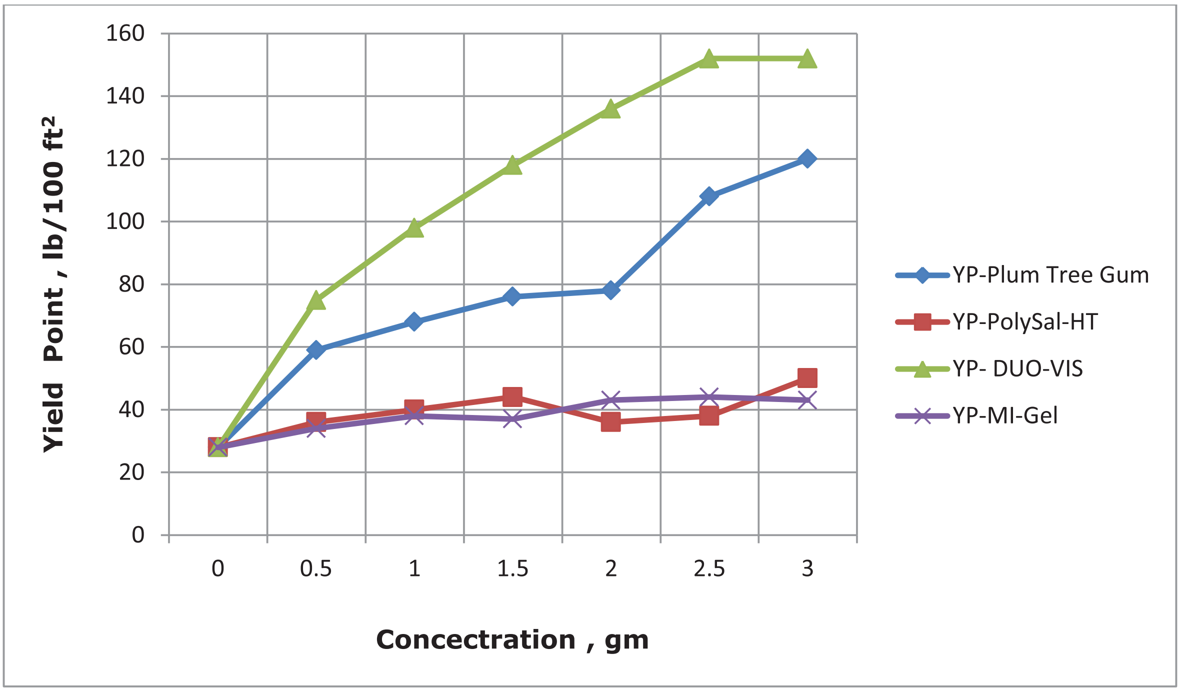

Fig. (5) Effect of additives concentrations on Yield Point (YP) for Plum Tree Gum, PolySal-HT, DUO-VIS and M-I Gel.

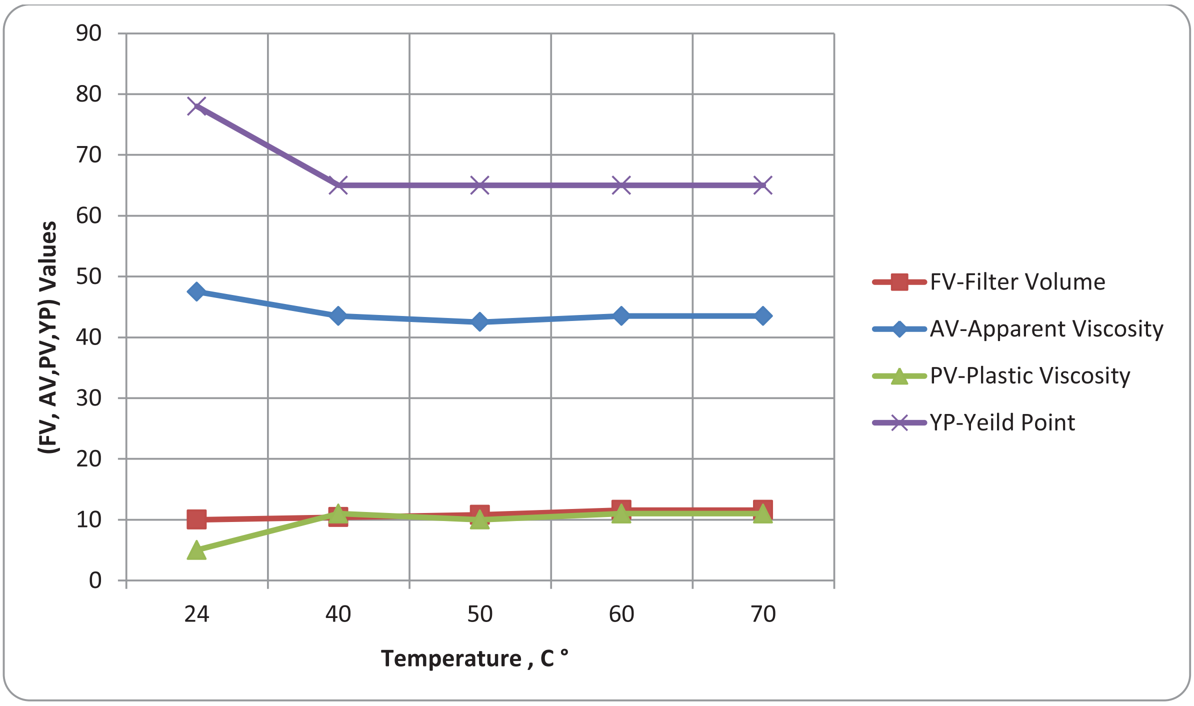

Fig. (6): Effect of Temperature on Rheological Properties of drilling fluid contain Plum Tree Gum.

Conclusions:

1- The rheological properties values of Plum Tree Gum was near from Poly-Sal HT values as a filtration control agents, Although Plum Tree Gum are ore polymer and Poly-Sal HT are manufacturing polymer, this material was succeeded in salt and salt saturated and deionized water as filter loss agent.

2- All rheological properties of Plum Tree Gum (apparent viscosity, plastic viscosity, and yield point) was greater than Poly-Sal HT for same concentrations

3-The material show good rheological properties as viscosifier agents, therefore we can advise to use it in preparation drilling mud.

4-Temperature effect a minimum increasing in filter volume and increased in plastic viscosity and minimum decreasing in yield of point.

Nomenclature

API	American Petroleum Institute
CMC-LVT	Carboxymethylcellulose — Low-viscosity, technical-grade
CMC-HVT	Carboxymethylcellulose — High-viscosity, technical-grade
R600	Shearing Stress reading at 600 rpm
R300	Shearing Stress reading at 300 rpm
R200	Shearing Stress reading at 200 rpm
R100	Shearing Stress reading at 100 rpm
R60	Shearing Stress reading at 60 rpm
R30	Shearing Stress reading at 30 rpm
R6	Shearing Stress reading at 6 rpm
R3	Shearing Stress reading at 3 rpm
10sec GEL	Gel Strength at 10 sec , $lb/100ft^2$
10min GEL	Gel Strength at 10 min , $lb/100ft^2$
AV	Apparent Viscosity , AV=R600/2 , cp
PV	Plastic Viscosity , PV=R600-R300 , cp
YP	Yield point, YP=PV-R300 , $lb/100ft^2$

References:

1 - Http://en.wikipedia.org/wiki/Natural_gum Polysaccharide

2- IUPAC, Compendium of Chemical Terminology, 2nd ed. (the "Gold Book") (1997). Online corrected version:"homopolysaccharide (homoglycan)", (2006).

3- Guo H, Yi W, Song JK, Wang PG. "Current understanding on biosynthesis of microbial.

4-http://www.slb.com/services/miswaco/services/drilling_fluid/df_products.aspx

5-"Specification for Drilling Fluids Materials", ANSI/API Specification 13A, 18th, FEB., (2010).

6- Instruction Manual, Updated 5/5/2014 Ver. 2.15,OFI Testing Equipment, Inc.,11302 Steeplecrest Dr.Houston, Texas·77065·U.S.A., Tele:832.320.7300.
Fax: 713.880.9886,, www.ofite.com,©Copyright OFITE (2013).