INVESTIGATION OF FLUIDS PROPERTIES, GRAIN SIZE AND DRAG FORCE EFFECTS ON SAND PRODUCTION

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INTRODUCTION

Sand production is annoying the petroleum industry by its adverse effects on thousands of oil and gas fields throughout the world. A tremendous amount of money is spent each year on attempts to predict and control sand influx and/or repair wells and equipment damaged by the sand produced.

Sand inflow into the well during production leads to casing abrasion and failure, formation damage, distortion, frequent sand removal and cleaning. Sand production can be caused from consolidation degree, reduction in pore pressure, production rate, and reservoir fluid viscosity. Also increasing of water cut may consider one of the sand production causes.

The sand control process has a major influence on the type of the well completion design and it influences the completion process. In addition, many wells are currently being produced below their potential in order to restrict sand influx or erosion. In this work we investigated the effect of fluid viscosity and formation grain size on sand production.

OBJECTIVE

Experimental investigation of production rate, fluids viscosity and grain size distribution effect on sand movement has been investigated using laboratory experiments using sand packs of different sizes and fluids representing Saudi reservoirs. The partial outputs present the effect of fluids drag forces and the sand size distribution on sand production.

MATERIALS

Table 1 list of the statistical analysis and petrophysical properties of two different types of sand packs representing Saudi reservoirs. The technique of laser diffraction has been used to measure the particles size distribution as shown in Figures 1 and 2.

Table 1 the statistical analysis and petrophysical properties of tested sands

Properties	Fine Sand Pack		Coarse Sand Pack	
Graphic Mean	1.703	Fine Grained	2.5	Medium Sand
Inclusive Graphic Standard Deviation	-0.439	Very Well Sorted	-0.961	Very Well Sorted
Inclusive Graphic Skewness	-0.076	Near Symmetrical	-0.424	Near Symmetrical
Kurtosis	0.956	Very Leptokurtic	2.151	Mesokurtic
Permeability (K)	3 Darcy		27 Darcy	
Porosity (Ø)	13 %		29 %	

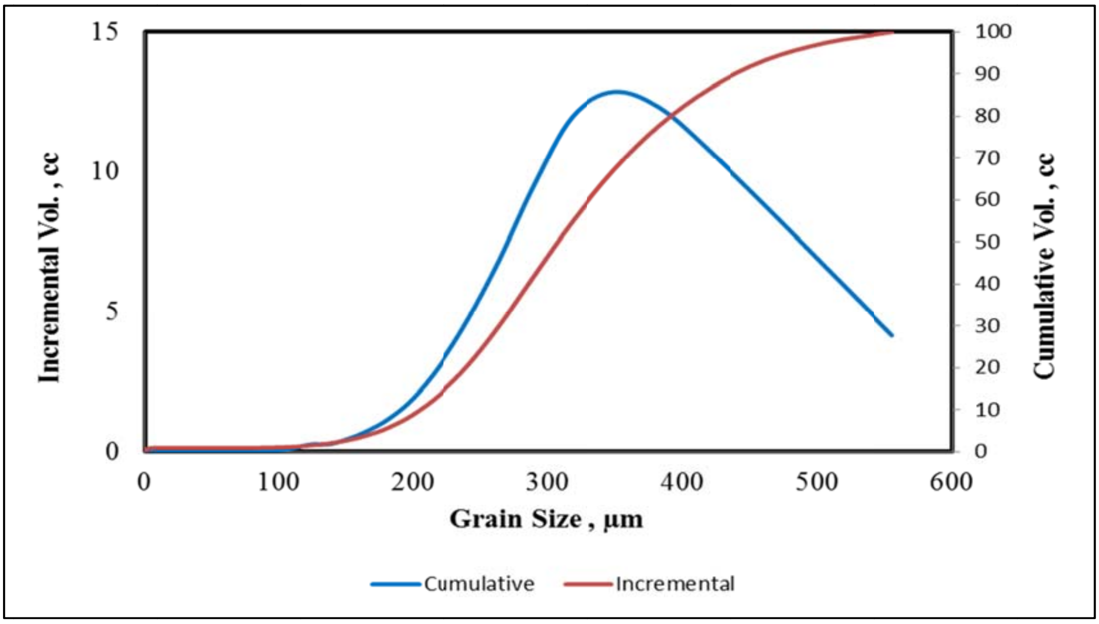

Figure 1: Coarse sand pack distribution

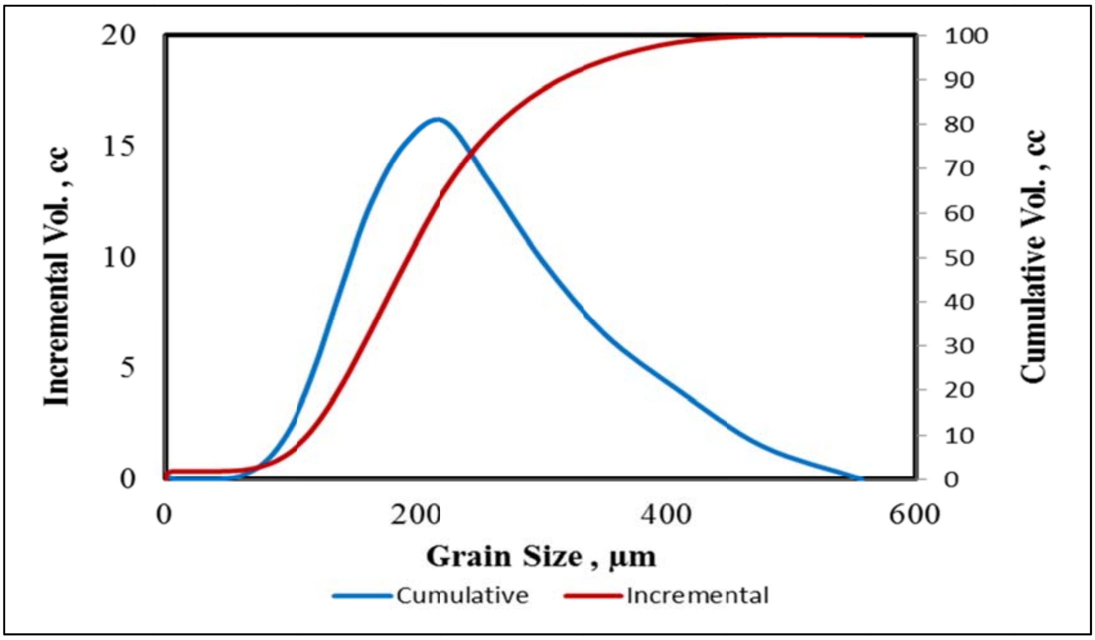

Figure 2: Fine sand pack distribution

EXPERIMENTAL SET-UP

Experimental work were conducted in several stages starting with sand packing, sand pack permeability measurement and determination of critical sanding velocity at which sand starts to be produced. Figure 3 shows the setup of the experiments.

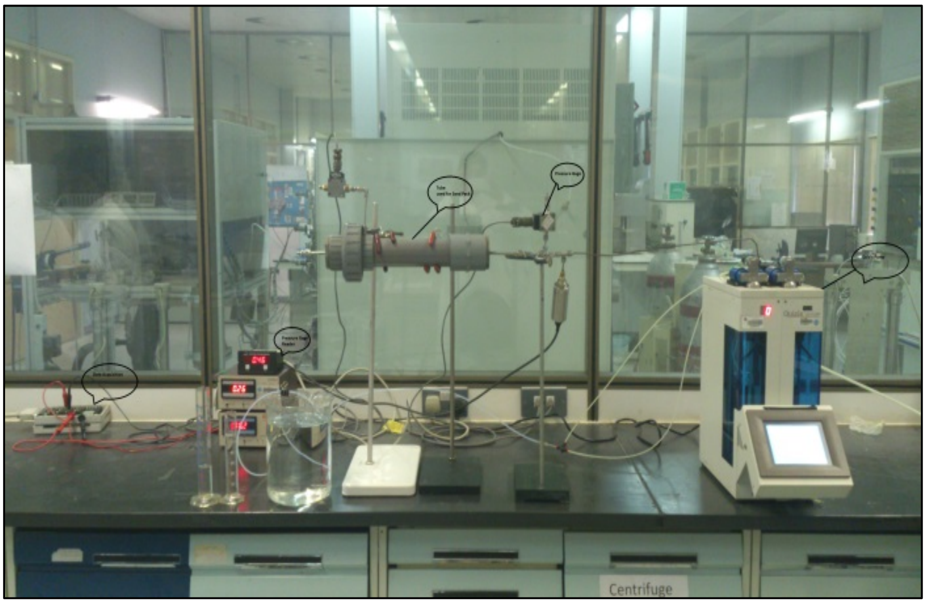

Figure 3: The experimental set-up

RESULTS & CONCLUSION

THE EFFECT OF FLUID VISCOSITY AND DRAG FORCE

Figure 4 and 5 indicates the increase of sand volume fraction with the increase of displacing fluid viscosity for both sand packs. Drag force depends on the fluid properties (*viscosity*, *density*) and on the size of sand particles (see Table 2). The sand volume fraction jumped by double in the case of the viscous fluid for coarse sand, while it jumped approximately 5 times for finer one. This phenomenon can be related to the high viscosity of the fluid. Hence drag force is directly proportion to fluid viscosity.

Table 2: Displacing fluids properties

Properties	**Distilled water**	**Crude Oil I**	**Crude Oil II**
Viscosity, cp	1	32	90
Density, gm/cc	1	0.843	0.896

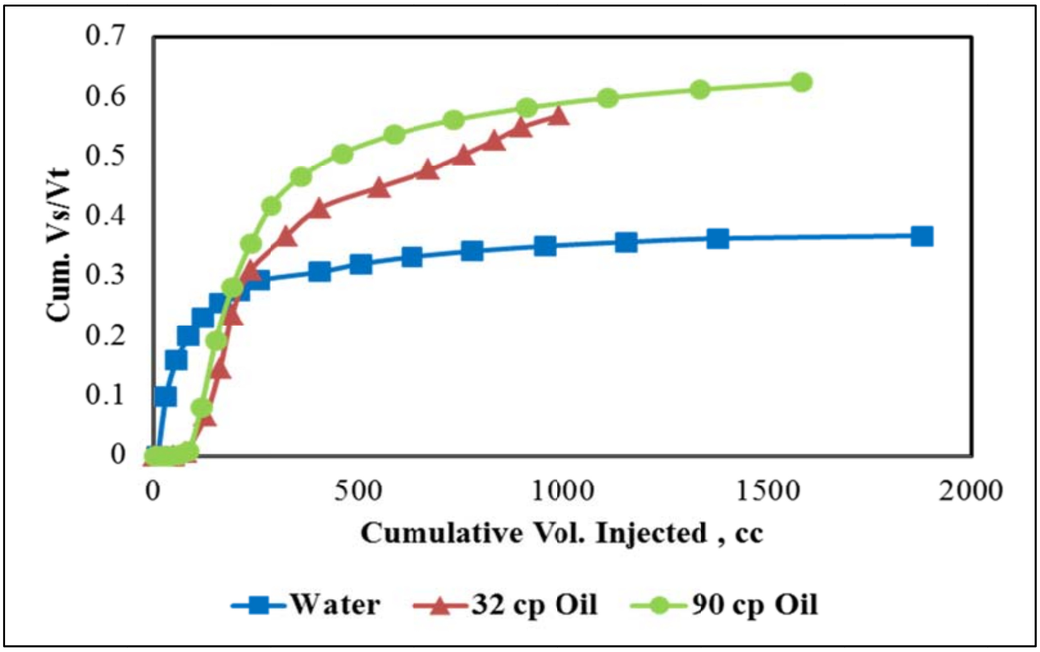

Figure 4: Cumulative coarse sand volume fraction versus the cumulative volume injected

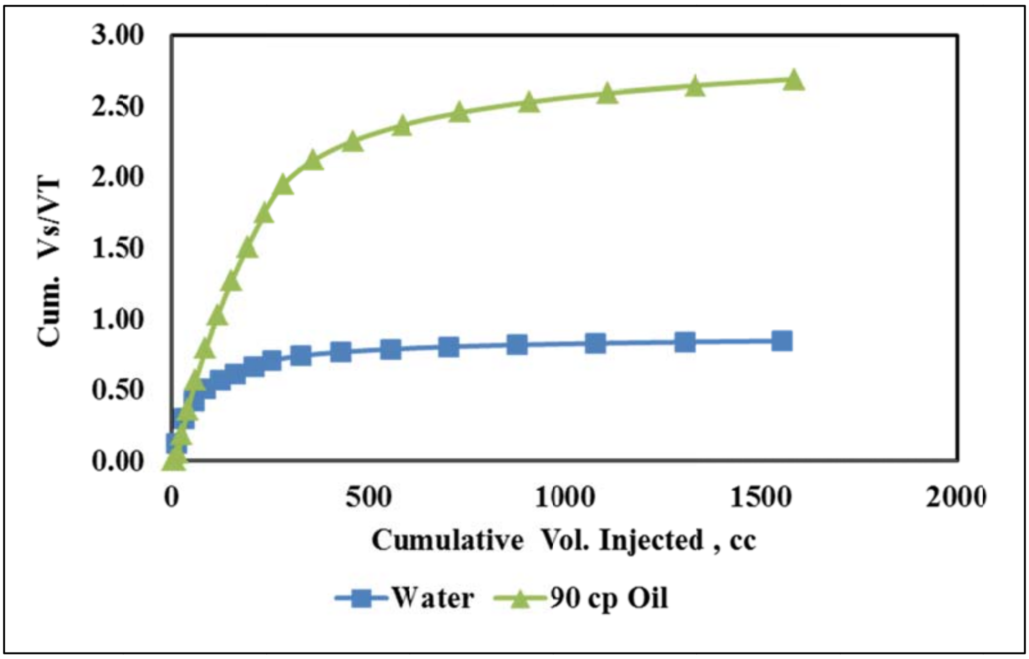

Figure 5: Cumulative fine sand volume fraction versus the cumulative volume injected

THE EFFECT OF SAND SIZE

Figure 6 and7 indicate higher sand production for finer sand regardless of displacing fluid. This can be attributed to the fluid ability to suspend finer sand particles compared to coarse particles.

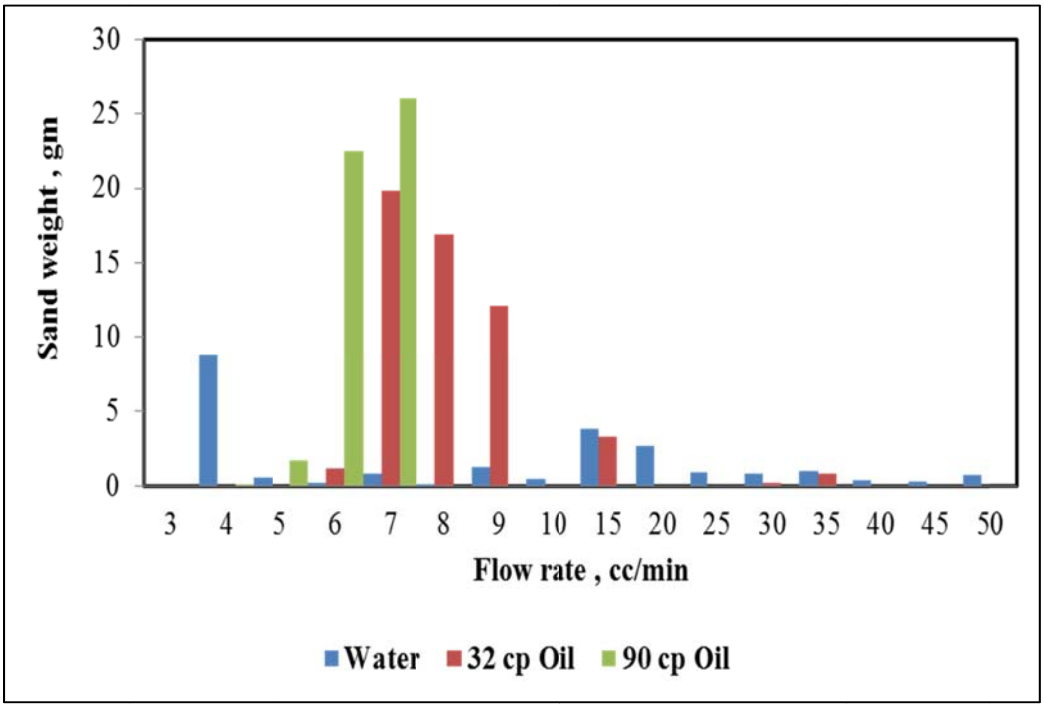

Figure 6: Cumulative sand volume fraction versus the cumulative water volume injected

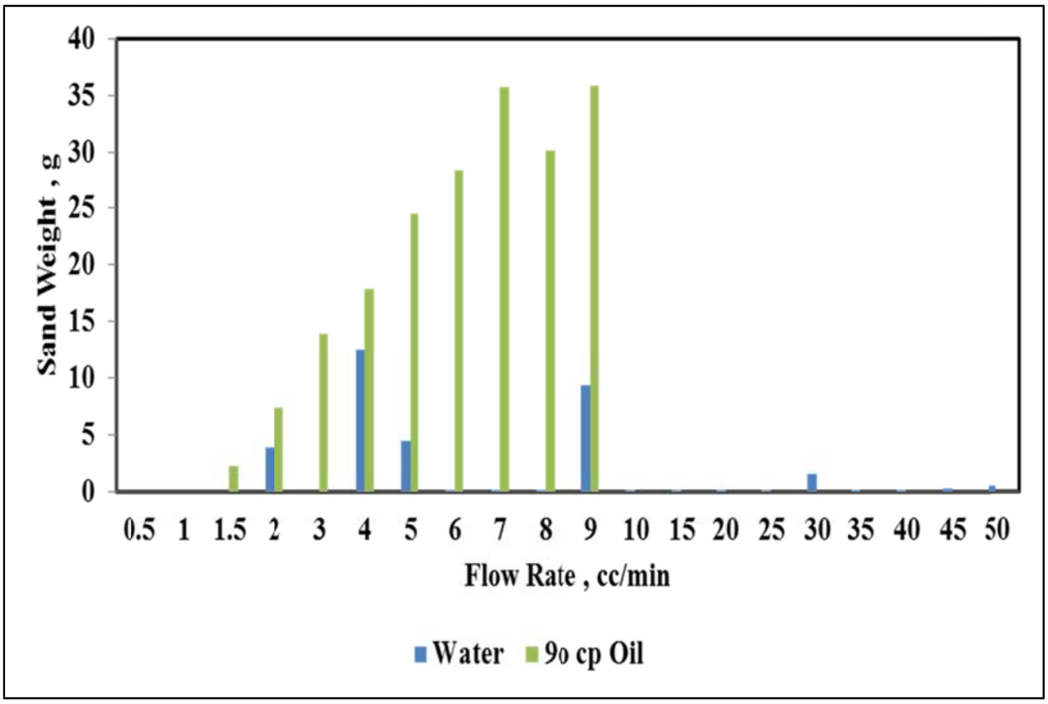

Figure 7: Cumulative sand volume fraction versus the cumulative crude oil volume injected

SHAPE OF EROSION EXPECTED AT PERFORATION

Figure 8 show the effect of velocity on erosion shape of the pay zone. We believed that the erosion shown in the previous figures is due to the high velocity in the centre of the pack for crude oil case, because of the adhesion and high friction on the outer side of the pack (crude oil and tube). While in water case the erosion is from the top due to the high velocity there.

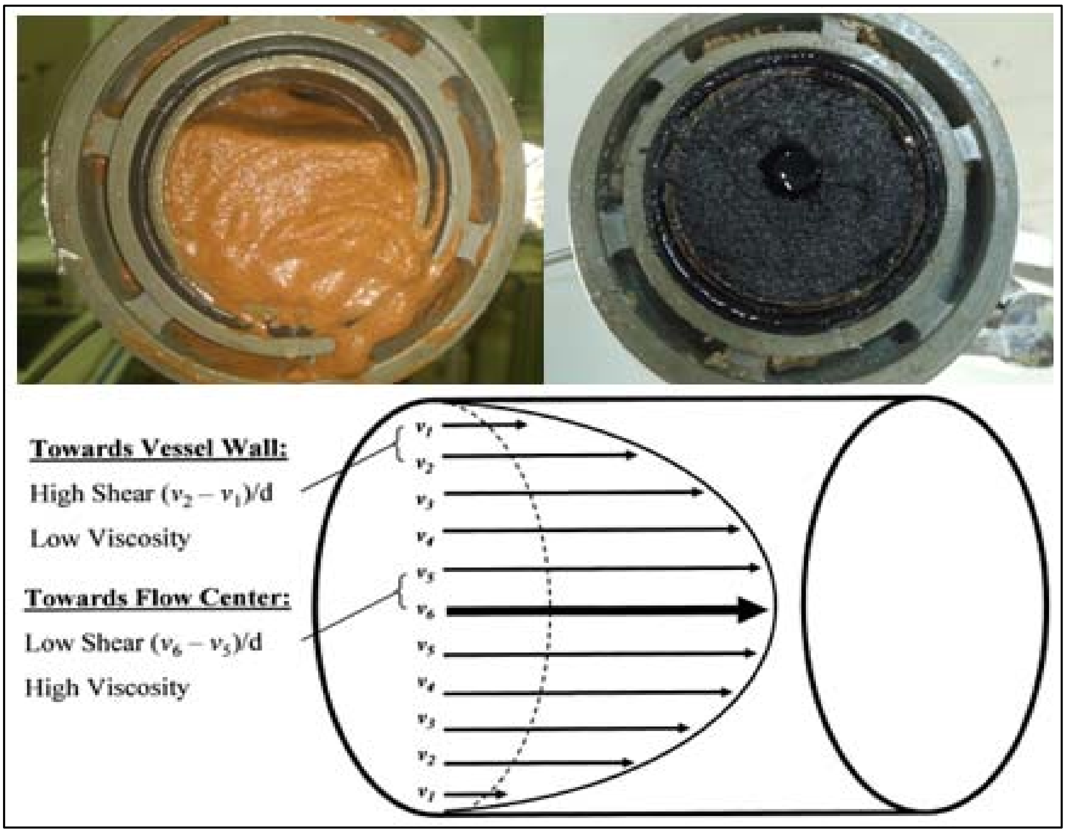

Figure 8: The relation between viscosity and velocity

CONCLUSION

- The fluid carrying capacity increases with the increase in viscosity and decrease with increasing carried sand size.
- Production of sand is continuous with time for the low viscous fluids.
- Presence of oil helps to stick sand particles to each other except at the centre where the fluid velocity is the highest