Solvent Extraction of Jordanian Oil Shale, Kinetics and Thermodynamic Study

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Introduction

Jordan has huge Oil Shale (OS) reserves spread over more than 24 near surface and deep occurrences across most Jordanian districts. The reserves are more than 50 billion tons. In this paper, solvent extraction of OS is performed on six samples obtained from four localities across the country (Fig. 1). Firstly, different pure and mixture organic solvents are used to determine the most suitable solvent type. Secondly, extraction parameters such as extraction time, temperature, pressure and agitation are investigated using a home-made reactor. The relevant kinetic data required to analyze and design an extraction process are obtained.

Experimental Setup

Soxhlet extraction was carried out for 24 hrs with eleven different solvents (Fig. 2). Also, a home-made reactor designed by the authors and manufactured in the Royal Scientific Society – Jordan (Fig. 3) was used to investigate the thermodynamics and kinetics of extraction.

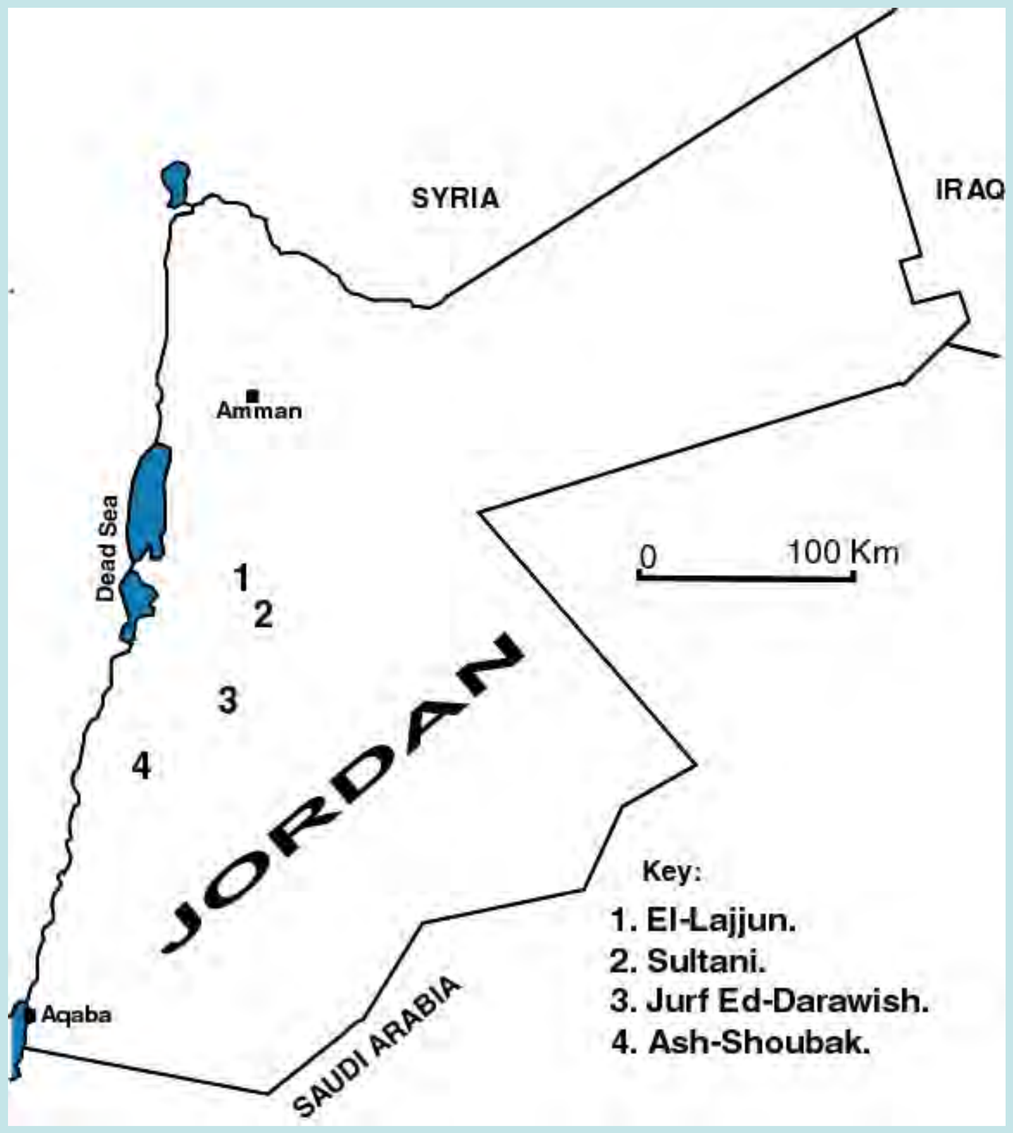

Fig.1: Oil Shale localities. Samples 1, 3, and 6 are from El-Lajjun (1), sample 2 is from Ash-shoubak (4), sample 4 is from Jurf Ed-darawish (3), sample 5 is from Sultani (2).

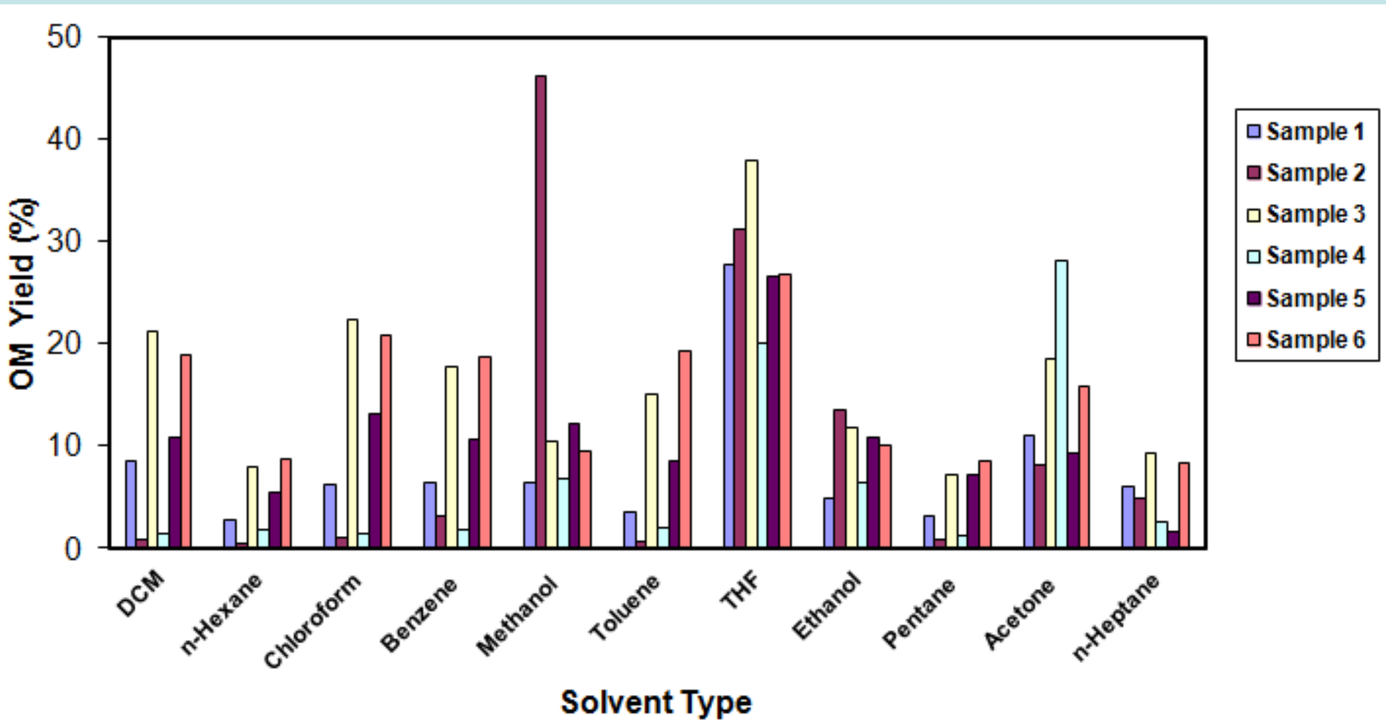

Fig. 2: Pure solvent extraction results using soxhlet for 24 hr and 4g oil shale.

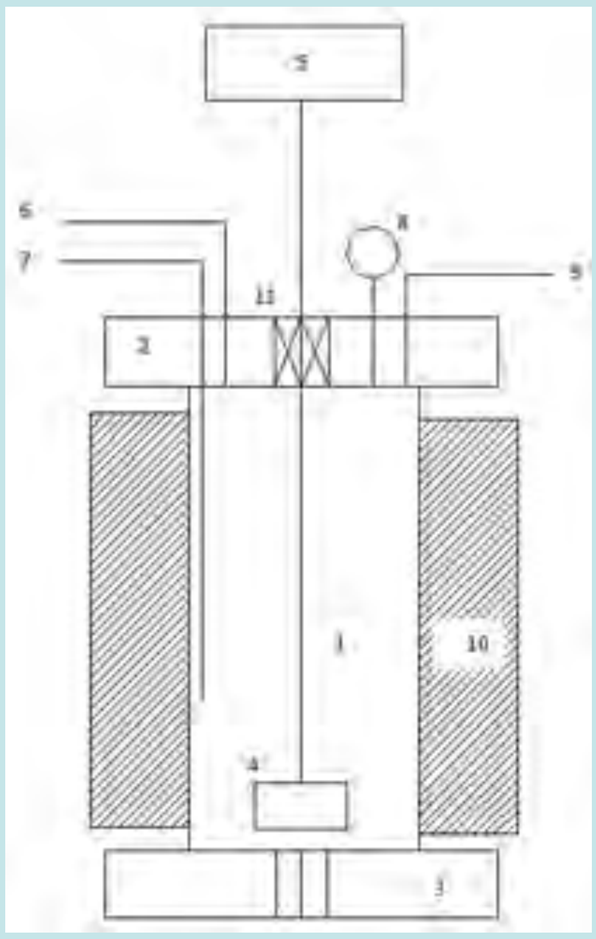

Fig. 3: schematic diagram of solvent extraction reactor.

1- main reactor body, 2-top cap, 3- bottom cap, 4- stirrer, 5- stirrer display and control, 6- liquid reactant line, 7- temperature measuring probe, 8- pressure measuring tap, 9- Nitrogen gas line, 10- Electric heater, 11- stirrer rod bearing and sealing.

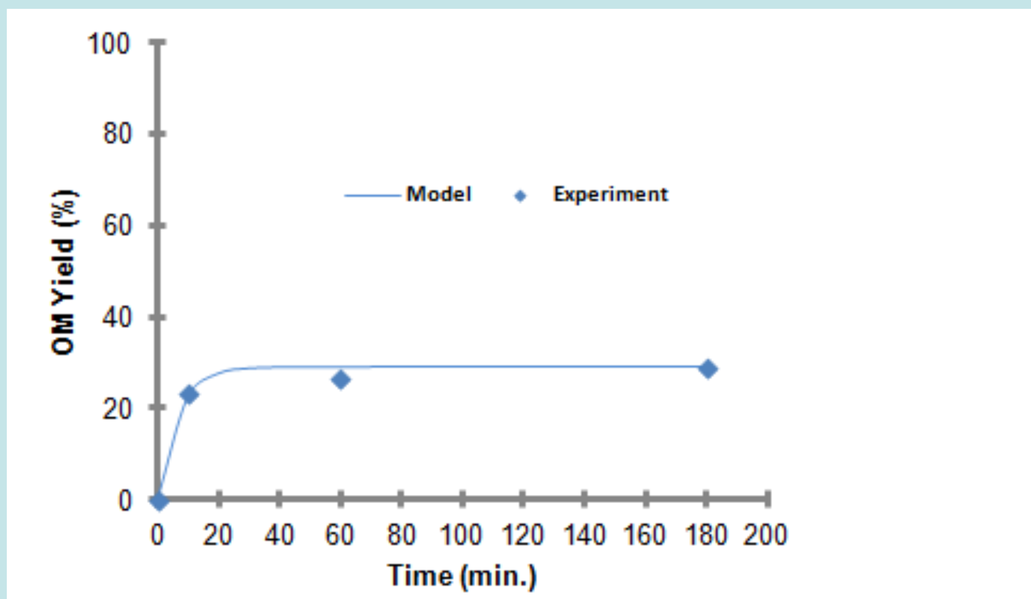

Fig.4: Extraction kinetics of OS using soxhlet method.

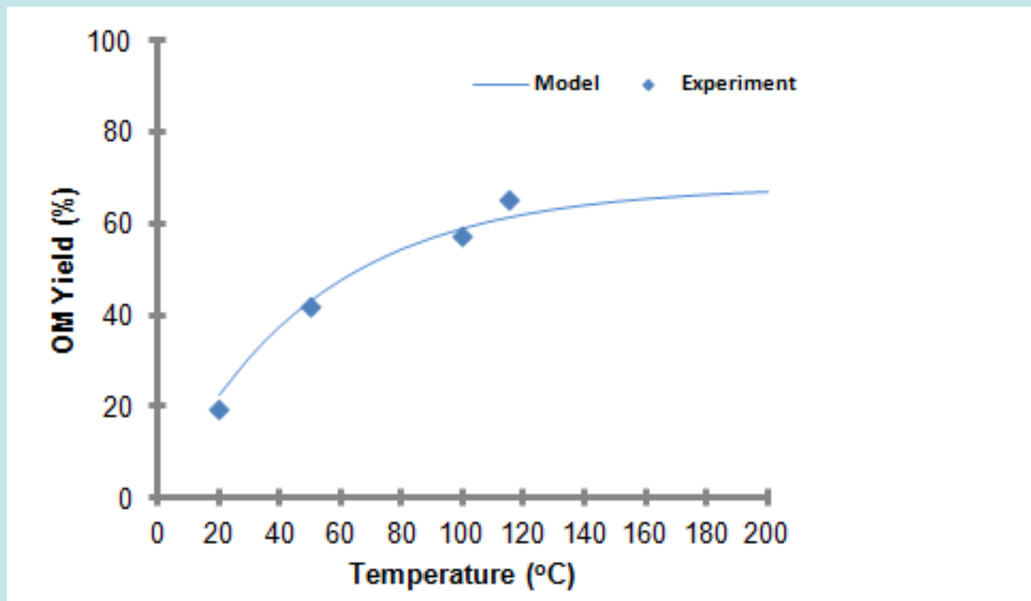

Fig.5: Extraction thermodynamics of OS using reactor. Pressure 5 bars and extraction time 10 min

Results

- Fig. 2 shows the variability of extracted yield with different samples and solvents. It is found that THF is the best pure solvent with yield more than 20%.

-Fig. 4 illustrates the kinetics of extraction process. The equilibrium yield is about 29% and volumetric mass transfer coefficient is 0.15.

- Fig. 5 illustrates the thermodynamics of extraction process using Chloroform, Acetone, and Methanol mixture. The equilibrium yield is 68% and temperature constant is 0.02. For mixture of THF and Acetone (not shown), the parameters are 55% and 0.023.

Conclusions

•The solvent extraction variability of OS in the same deposit and between the main deposits should be taken into account in selecting the most relevant processing technology.
•THF is found the best pure solvent for the different samples with yield greater than 20% using soxhlet extraction.
•Using proper thermodynamic and kinetic conditions, equilibrium yield could reach 68%.

Literature

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