TEAM 45

Microwave-Assisted In-Situ Oil Shale Extraction

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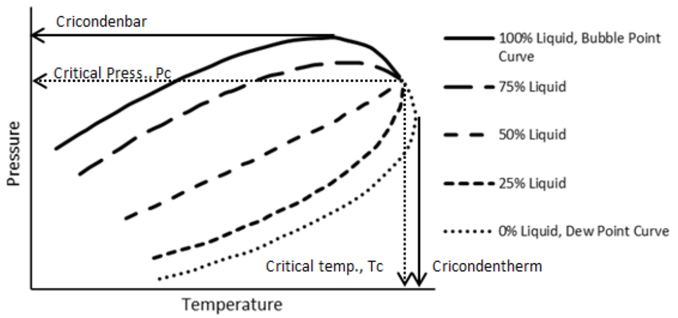
Introduction

Problem Statement:
Conventional extraction methods struggle with tight formations and highly viscous heavy crude, resulting in low natural gas recovery and high extraction costs. Large volumes of gas remain unrecovered in reservoirs, and heavy crude requires significant energy to mobilize. A new heating approach is needed to improve recovery efficiency and reduce operating costs.

Solution:
MAVE's microwave-assisted technology delivers rapid, uniform volumetric heating that enhances fluid mobility and recovery. Prototype testing using a 700 W microwave, heavy crude samples, temperature measurements, and viscometer analysis showed strong performance. This approach can enable the recovery of up to 25% of unrecovered natural gas and achieve more than a 30% reduction in heavy crude extraction costs through faster heating and improved flowability.

Liquid Vapor Diagram



Constraints	Specifications
Input Power: 220V AC/ 60Hz	Heating Uniformity +-10C
Material: Thick-walled Glass Container	Maximum Temperature 310C
Operational: Atmospheric/ Inert Atm.	Viscosity Reduction >= 30%
Budget <= 10k SAR	Source: 2.45 GHz Magnetron
Time <= 13 Weeks	Energy Reduction >= 25%
	Microwave leakage < 3mW/cm2

Mave In Numbers

Natural Gas

25%

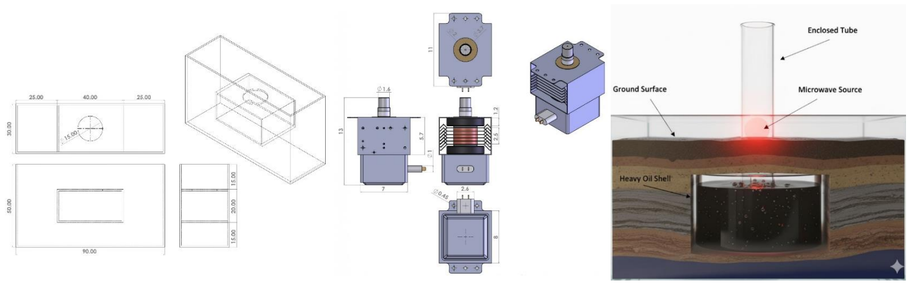
"Mave's Microwave-Assisted Technology results in the recovery of 25% of the unrecovered natural gas reservoirs".

Heavy Crude Oil

30%

"Mave's Microwave-Assisted Technology results in a reduction of more than 30% in the cost of heavy crude oil extraction".

Prototype Design



Function	Prototype Component
Durability & Corrosion protection	• Thick-walled glass container • Containing heavy crude oil from Othmaniyah well to resist corrosion and tolerate repeated heating cycles.
Real-Time Monitoring & Data Collection	• Rotational Viscometer (to measure viscosity changes after heating) • K-type Thermocouples (to measure temperature after multiple microwave tests)
Heat Generation	• 700 W Household Microwave Oven • Used to heat heavy crude samples and observe viscosity reduction behavior and temperature.
Heat Transfer & Sample Handling	• Quartz Crucible (microwave-transparent container for crude oil) • Ceramic Fiber Insulation (minimizes heat loss), • Controlled heating cycles for uniform exposure of heavy crude oil samples.

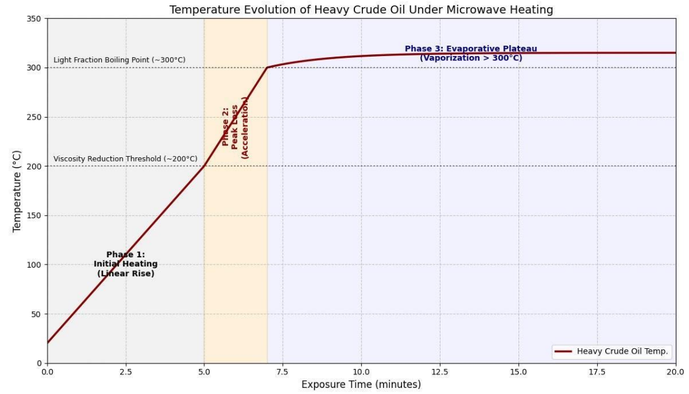
Testing / Validation

Readings After Microwave Exposure

No.	Step Time (seconds)	Viscosity (cP)	Temperature (C)
1	5.00800	697.74	25.00
2	10.0040	697.54	25.00
3	15.0160	697.42	24.99
4	20.0120	697.28	25.00
5	25.0000	697.48	25.01

Readings After Microwave Exposure

No.	Step Time (seconds)	Viscosity (cP)	Temperature (C)
1	5.01200	61.57	70.02
2	10.0160	61.44	70.01
3	15.0080	61.31	70.00
4	20.0080	61.17	70.00
5	25.0200	61.05	69.99



Conclusion

Testing confirmed that microwave heating significantly reduces the viscosity of the heavy crude and improves energy efficiency compared to conventional methods. Combined with its potential to recover 25% more natural gas and cut heavy-oil extraction costs by over 30%, Mave's technology demonstrates a promising path toward cleaner, faster, and more economical hydrocarbon recovery.