

EFFECT OF RESERVOIR FLUID COMPOSITION ON GAS RECYCLING
IN GAS CONDENSATE RESERVOIRS

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ผลกระทบขององค์ประกอบของของไหลในแหล่งกักเก็บในการอัดก๊าซกลับคืนในแหล่งกักเก็บ
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ชัยพร กิตติรัตน์ ไพบูลย์ : ผลกระทบขององค์ประกอบของของไหลในแหล่งกักเก็บในการ
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การศึกษานี้ได้ทำการศึกษาเพื่อประเมินความเป็นไปได้ที่จะทำการอัดก๊าซกลับคืนในแหล่ง
 กักเก็บก๊าซธรรมชาติเหลวที่มีร้อยละของไฮโดรคาร์บอนในองค์ประกอบของของไหลที่
 ต่างกัน

ในการศึกษานี้แบบจำลองแหล่งกักเก็บแบบง่ายถูกสร้างขึ้นและได้เลือก 10 กลุ่มของร้อย
 ละของไฮโดรคาร์บอนในองค์ประกอบของของไหลจากข้อมูลจริงโดยนำมาเป็นข้อมูลของ
 แบบจำลอง เพื่อที่จะศึกษาผลกระทบของร้อยละของไฮโดรคาร์บอนในองค์ประกอบของของ
 ไหลในความเป็นไปได้ในการอัดก๊าซกลับคืนในแหล่งกักเก็บก๊าซธรรมชาติเหลว โดยเครื่องมือทาง
 เศรษฐศาสตร์ได้ถูกนำมาวิเคราะห์ในแต่ละกรณี

ผลจากการศึกษานี้สามารถสรุปได้ว่ายิ่งค่าร้อยละของไฮโดรคาร์บอนในองค์ประกอบของ
 ของของไหลในแหล่งกักเก็บก๊าซธรรมชาติเหลวที่มากกว่า 5 และ 7 และ ค่ามวลโมเลกุล มีค่ามาก
 ก๊าซธรรมชาติเหลวจะถูกผลิตมากขึ้น แต่ผลการผลิตสะสมของก๊าซของทั้งกรณี ผลิตโดยธรรมชาติ
 และการผลิตโดยการอัดก๊าซกลับคืนในแหล่งกักเก็บก๊าซธรรมชาติเหลว ได้ผลการผลิตสะสมที่
 ใกล้เคียงกัน ในทางเศรษฐศาสตร์เมื่อค่าร้อยละของไฮโดรคาร์บอนในองค์ประกอบของของ
 ไหลในแหล่งกักเก็บก๊าซธรรมชาติเหลวที่มากกว่า 5 และ 7 และ มวลโมเลกุลมีค่ามาก มักจะให้
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This study is performed to evaluate the feasibility of gas recycling in gas condensate reservoirs having different compositions.

In this study, a simple reservoir model was constructed and 10 sets of compositions from actual field data were selected as input for compositional reservoir simulator; ECLIPSE 300 to study the effect of fluid composition on the feasibility of gas cycling application. Economics analyses were performed in order to evaluate each simulated scenario.

From the simulation results, it can be concluded that the higher the mole percentage of C_{5+} and C_{7+} and molecular weight of the compositions, the higher recovery of hydrocarbon liquid can be recovered. The gas cumulative production recovery by natural depletion and gas cycling methods are more or less the same. In term of economics, fluid compositions with greater mole percentage of C_{5+} and C_{7+} and molecular weights generally result in higher NPV and IRR and shorter payback period.

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List of Abbreviations

AIM	Adaptive IMPLICIT
API	degree (American Petroleum Institute)
bbl	barrel (bbl/d : barrel per day)
BTU	British thermal unit
C ₁	methane
C ₂	ethane
C ₃	propane
i-C ₄ or I-C ₄	isobutane
i-C ₅ or I-C ₅	isopentane
n-C ₄ or N-C ₄	normal butane
n-C ₅ or N-C ₅	normal pentane
C ₆	hexane
C ₇₊	alkane hydrocarbon account from heptanes forward
CO ₂	carbon dioxide
CGR	condensate gas ratio
D	darcy
EOS	equation of state
FGPT	field gas production total
FOPT	field oil production total
IMPES	IMPLICIT Pressure, EXPLICIT Saturations
IRR	internal rate of return
K	kilo- (10 ³ or 1,000)
M	¹ thousand (1,000 of petroleum unit), ² million (dollar)
MSCF/D	thousand standard cubic feet per day
NEI	non-equilibrium initialisation
NPV	net present value
PVT	pressure-volume-temperature
PSIA or psia	pounds per square inch absolute
SCAL	special core analysis
SGAS	gas saturation
SGFN	gas saturation function

SOFN	oil saturation function
STB or stb	stock-tank barrel
STB/D	stock-tank barrels per day
SWAT	water saturation
SWFN	water saturation function
TVD	true vertical depth or total vertical depth
VLE	vapor/liquid equilibrium
BHP	bottom hole pressure
GIR	gas injection rate
GPT	gas production total
GPR	gas production rate
OPR	oil production rate
OPT	oil production total

Nomenclature

a	attraction parameter
a_T	temperature-dependent coefficient in Peng-Robinson equations of state
A	cross-section area
b	repulsion parameter
c_g	gas compressibility
E	areal sweep efficiency at breakthrough
k	¹ permeability, ² discount rate (cost of capital)
k_{rg}	gas relative permeability
k_{rw}	water relative permeability
k_{rog}	oil relative permeability for a system with oil, gas and connate water
k_{row}	oil relative permeability for a system with oil and water only
k_{rowg}	oil relative permeability for a system with oil and water at $S_g = 0$
K	equilibrium constant
M	molecular weight
M_g	apparent molecular weight of gas
m	mass per unit volume
\dot{m}	mass flux (mass per unit area per unit time)
n	¹ last period of project, ² number of mole
O_t	cash outflow in period t
p	pressure
p_c	capillary pressure
\sim	
q	volumetric flow rate
Q	mass injection or production
r	internal rate of return (<i>IRR</i>)
R_t	cash inflow in period t
R	universal gas constant
S	saturation
t	time period (e.g., year)
u_x	flow velocity

V_b	bulk fluid volume
x	liquid phase
y	¹ mole fraction of component in gas, ² vapor phase
z	compressibility factor

GREEK LETTER

ϕ	¹ porosity, ² coefficient of fugacity
f	fugacity
ρ	fluid density (mass/volume)
μ	¹ fluid viscosity, ² chemical potential
Δ	difference operator
α	¹ constant in temperature-dependent coefficient for Peng-Robinson equation of state, ² fractional mole of gas
Ω	constant in equation of state
ω	acentric factor of the component
δ	binary interaction coefficients

SUPERSCRIPTS

n	current time level
$n+1$	new time level

SUBSCRIPTS

A	areal
c	critical property
d	displacement
g	gas
i	¹ grid block location, ² component i , ³ invasion
j	component j
k	component k
o	oil
r	reduced
w	water