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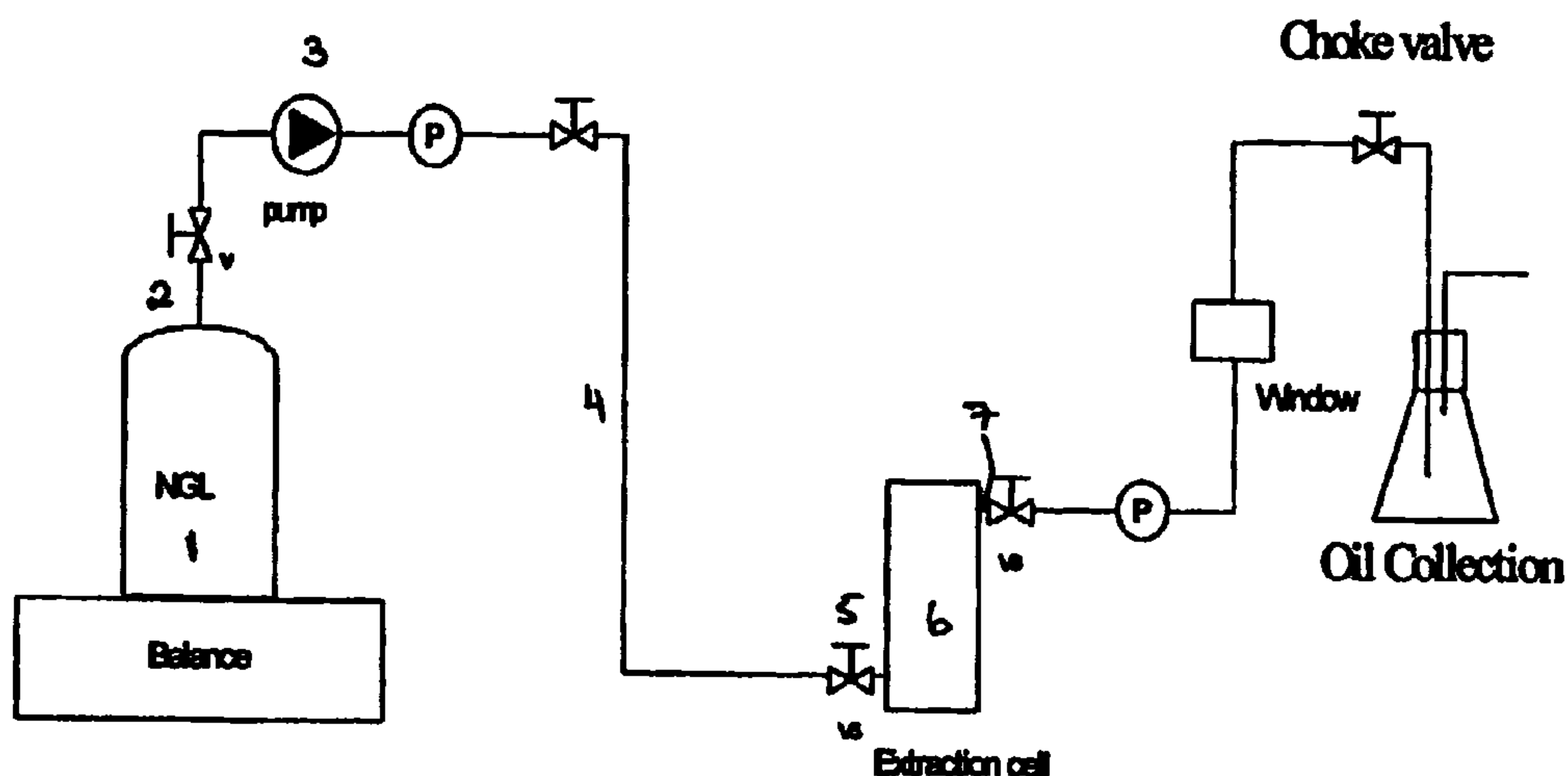
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(54) **NETTOYAGE DES DEBRIS DE FORAGE ET DISPOSITIF  
CORRESPONDANT**

(54) **CLEANING OF DRILL CUTTINGS AND APPARATUS  
THEREFOR**



(57) L'invention concerne un procédé et un dispositif permettant d'éliminer dans des solides particulières les contaminants organiques non polaires qui renferment du pétrole, résultat que l'on obtient en mettant lesdits solides en contact avec un agent d'extraction.

(57) The present invention comprises a process and apparatus for removing nonpolar organic contaminants including oil from particulate solids, wherein said solids are brought in contact with an extracting agent.



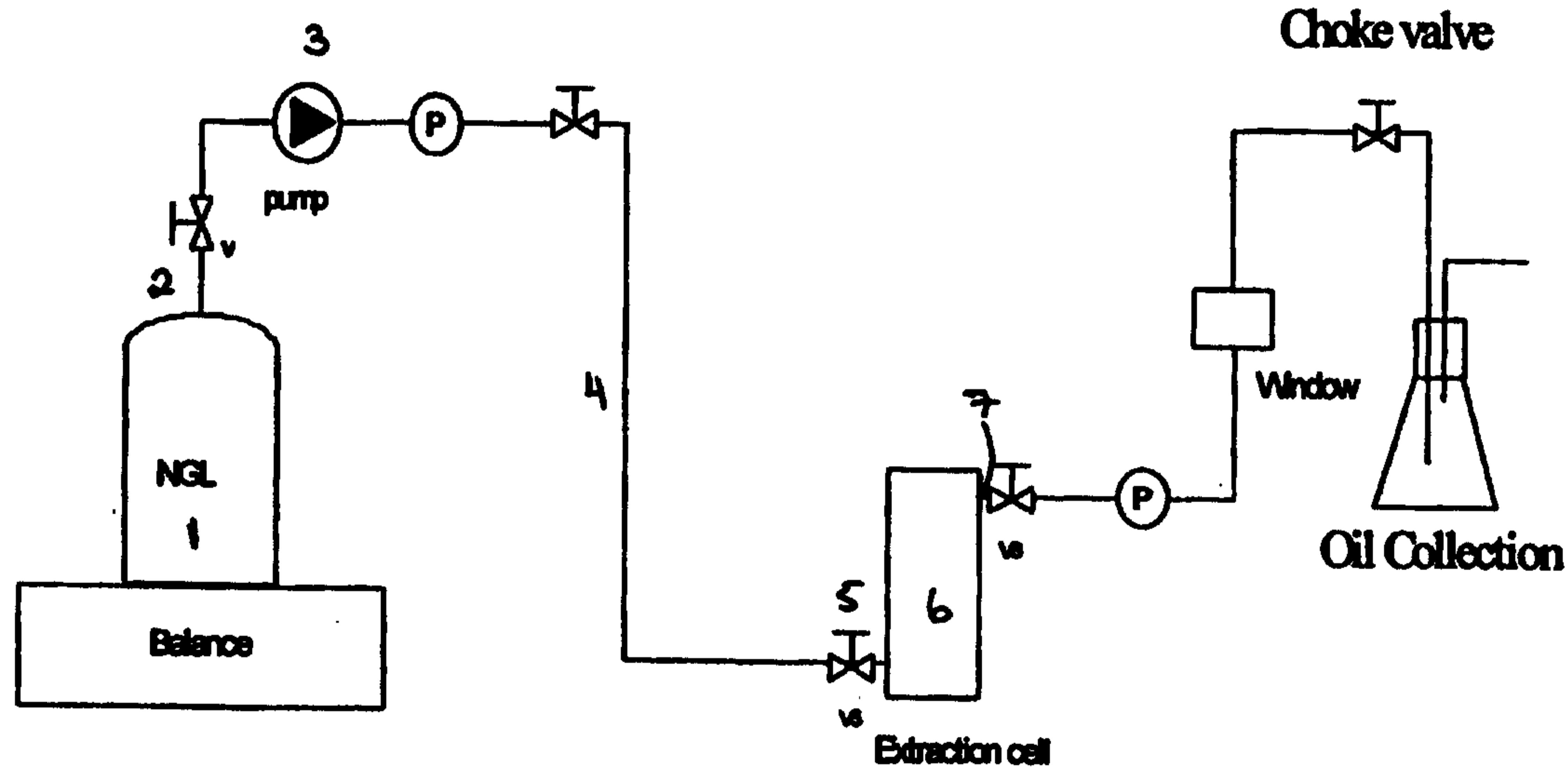
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/NO99/00037</p> <p>(22) International Filing Date: 3 February 1999 (03.02.99)</p> <p>(30) Priority Data: 60/073,546 3 February 1998 (03.02.98) US</p> <p>(71) Applicant (for all designated States except US): CAGNIARD DE LA TOUR AS (CTOUR) [NO/NO]; P.O. Box 2503 Ullandhaug, N-4004 Stavanger (NO).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): HENRIKSEN, Inge, Brun [NO/NO]; Lagaardsvei 131, N-4010 Stavanger (NO).</p> <p>(74) Agent: MARKUSSEN, Tone, Furan; Bryn &amp; Aarflot AS, P.O. Box 449 Sentrum, N-0104 Oslo (NO).</p>	<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</p>	

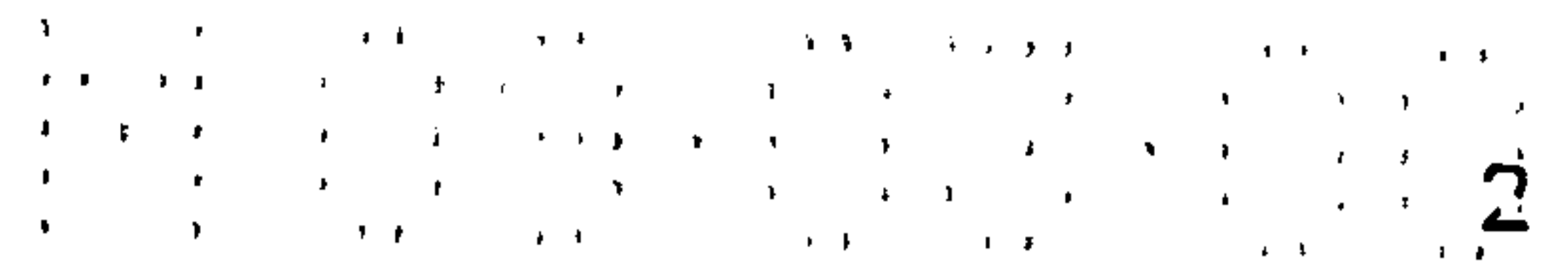
(54) Title: CLEANING OF DRILL CUTTINGS AND APPARATUS THEREFOR



## (57) Abstract

The present invention comprises a process and apparatus for removing nonpolar organic contaminants including oil from particulate solids, wherein said solids are brought in contact with an extracting agent.





produced water. The process does not include removal of organic contaminants from solids.

The use of supercritical extraction techniques to remove and recover oil from cuttings was first proposed in 1981 by C.P.Eppig et al in US-patent no. 4.434.028. US 4.434.028 relates to a method and apparatus for removing oil and other organic constituents from inorganic-rich mineral solids, particulate drill cuttings. The solids to be treated are transferred into pressure vessel means wherein they are contacted with an extracting agent which is normally a gas such as e.g. dichlorodifluoromethane, propan, carbondioxide, ethane and ethylene. The gas is under condition of pressure and temperature to provide the extracting in a fluidic solvent state for the constituents to be removed. The extracting containing the constituents is withdrawn from the pressure vessel and depressurized and forms a two-phase system. The two-phase system can be separated by distillation into a vapour phase containing the extracting and a liquid phase containing oil and organic constituents. The method described in US 4.434.028 is a very expensive extraction process comprising the use of pure gas components as an extracting agent followed by compression- and to-steps distillation procedures to fully recover the extracting agent which is pure gas components. In order for the process to be economic feasible, full recovery of the extracting agent (99.7%) is required. The process described in US 4.434.028 is based on using liquid gas (i.e.CO<sub>2</sub>, Propane or Freon) to extract the oil and to fully recycle the gas (99.7%). The proposed process has apparently never been scaled up to an industrial plant .

US-A-4485079 discloses a process for removing nonpolar organic contaminants in a three-step serial extraction process for separating residual heavy organic contaminants from solids, where each step has the following main characteristics.

Step 1: Contacting the solids with a hydrocarbon fluid composed of 2 to 9 carbon atoms.

Step 2. Contacting the solids from Step1 with a second hydrocarbon fluid that is capable of dissolving part of the heavy contaminants from the solids.

Step 3: Contacting the solids from Step 2 with a third hydrocarbon fluid composed of 2 to 9 hydrocarbon atoms to extract part of the residual hydrocarbon fluid from step 2.

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This process is distinct from the present invention in that the extraction is conducted in three steps where different solvents are used at each step. It should be stressed that the present invention is a one step extraction process for removing nonpolar organic contaminants in which only one extracting agent (NGL) is added.

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WO-A-9108375 concerns an extraction method and apparatus which uses organic solvent, i.e. toluene or stabilised gasoline. WO-A-9108375 requires regeneration of solvent and a dryer to remove residual solvent from the cleaned cuttings. This is distinct from the present invention in that said invention uses pressurised natural gas liquid which is volatile at ambient conditions and which is available from a production flow-line and requires no regeneration.

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As the oilfields matures and the water-cut increases, more sand from the reservoir formation tends to follow the production stream in some oilfields. The sand settles in the separators and are periodically washed out and disposed by re-injection or brought ashore for disposal or processing. One object is therefore to provide an inventive and cost-effective process for cleaning of oily-drill cuttings and sand to allow overboard discard of the cuttings.

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The present invention concerning a method of extracting oil from drill cuttings and sand offshore. The method is based upon using natural gas liquid (NGL) as a solvent to extract the oil from the solids. The process has been successfully tested in lab-scale and the results shows less than 1.0% by weight of the maximum residual oil content for overboard disposal of drill cuttings. Further, the present invention reduces the investment and operation costs to a fraction of that which was proposed in US 4.434.028 since NGL is available from the production flow-lines at most oil and gas production facilities. Further, the present process is considerably distinct from other extraction processes in that it is carried out with no «solvent-recovery». One further object with the present invention is a significant saving in chemical costs and utility requirement compared to re-injection or on-shore disposal of drill cuttings.

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- The NGL has to be in liquid state at the pressure and temperature of extraction.
- The NGL has to be in gaseous state at atmospheric pressure at the extraction temperature.

It is apparent from the phase diagram of the available NGL (Figure 2) that at 60°C,  
 5 the minimum extraction pressure is approximately 20 bar.

The extraction cell was always first completely filled with the drill cuttings (about 630-660 g) and then completely flooded with NGL (about 600 ml) at a pressure of 30 bar, agitation was applied by turning the extraction cell up side down twice.

Table 3 shows the results. The "void volume = 694 ml" is defined as the volume of  
 10 NGL which can be added to the extraction cell containing the drill cuttings plus the volume of the tube connecting the cell to the choke valve.

Table 2: Molar compositions of NGL

<b>Methane</b>	0.0336	<b>Butane</b>	0.1848
<b>Ethane</b>	0.1272	<b>Ipentane</b>	0.1102
<b>Propane</b>	0.1984	<b>Pentane</b>	0.1620
<b>Ibutane</b>	0.0754	<b>Hexane</b>	0.1074

Table 3: Extraction of 623.7 g drill cuttings (34/10-D4H) with NGL at 30bar, 60°C

V(liquid gas) [ml]	void volumes	m(oil) collected [g]	removed oil [wt %]	[wt %] Wet basis
694	1	0	0	7.20
932	1.3	4.9	10.9	6.46
1156	1.7	16.4	36.5	4.69
1268	1.8	21.3	47.4	3.92
1550	2.2	27.4	60.9	2.94
2060	3.0	33.3	74.1	1.97
2550	3.7	39.5	87.9	0.93
2920	4.2	41.4	92.1	0.61
3278	4.7	42.4	94.3	0.44
3914	5.6	43.2	96.1	0.30
4280	6.2	43.3	96.3	0.28

Figure 3 shows the residual oil content (related to the wet sample) on the drill cuttings versus the void volume of NGL injected. It is apparent from Figure 3 that the initial oil concentration of 7.2 wt % remains in the cell until it is flooded with the first void volume of NGL. Upon additional injection of NGL, a reduction of the oil content is evident. It is apparent that each time one void-volume is injected, the concentration is reduced by approximately 50%. The experimental data were consequently compared with the relationship expected from a pure dilution process. The following general equation were used for the dilution-model:

$$C=C_0*0.5^{(n-1)}$$

wherein:

$C_0$ = Initial oil concentration

$C$ = Residual oil concentration

$n$ = number of void volumes injected

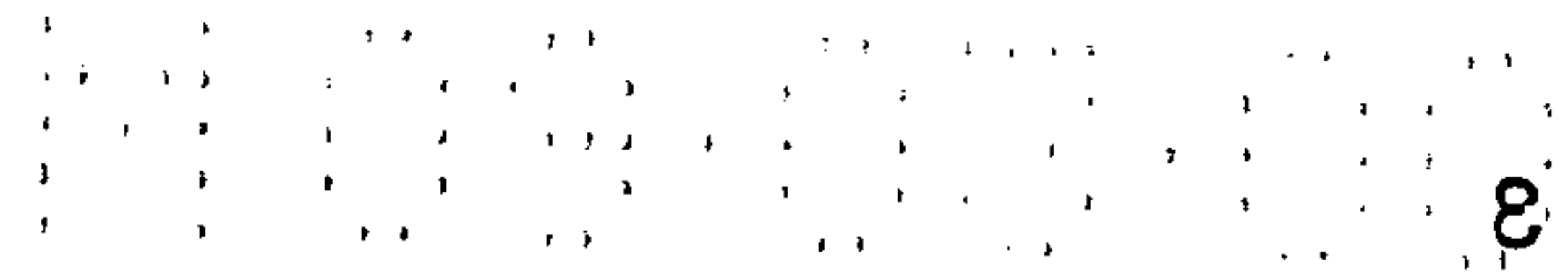


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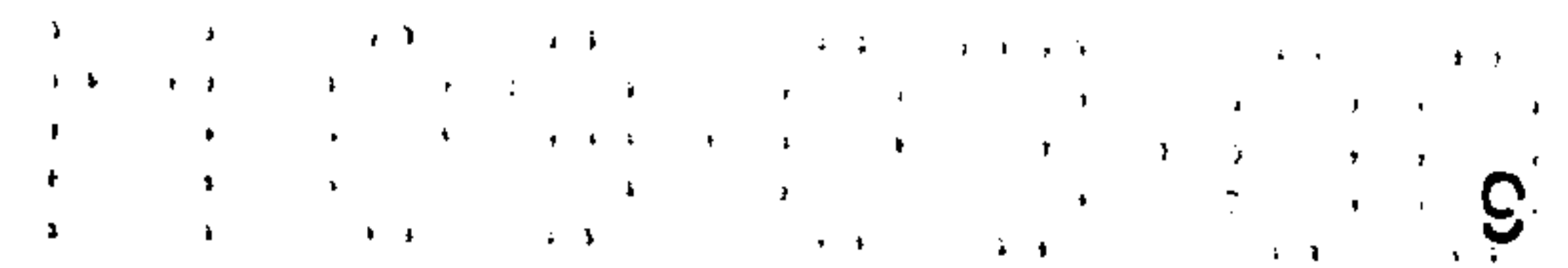
wherein:

$C_0$ = Initial oil concentration

C= Residual oil concentration

n= number of void volumes injected

AMENDED SHEET



The experimental data correspond very well with the graph for the dilution model as illustrated in Figure 3. It is apparent that the NGL-extraction of the oil from cuttings obeys the rules for dilution. Which indicates that the oil is already completely dissolved in the NGL at the first void volume. It is therefor reasonable to assume  
 5 that the extraction process is fast and exhibits no significant mass-transfer restrictions.

All drill cuttings which were tested, exhibited the same behaviour as presented in Figure 3 and the results are summarised in Table 4.

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Table 4: Oil concentration (weight %) before and after extraction with NGL

Drill cuttings	34/10-D4H (Gullfaks)	34/10-G-2T2H (Gullfaks)	30/3-A9A (Veslefrikk)
Initial concentration	7,2	9.0	18,6
Residual concentration (wet basis)	0.28	0.37	0.22
Residual concentration (dry basis)	0.26	0.34	0.20

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**C L A I M S**

1. A process for removing nonpolar organic contaminants including oil from particulate solids, wherein said solids are brought in contact with an extracting agent characterised in that:
  - a) the particulate solids are conveyed into a pressure vessel to which an extracting agent is added in the form of natural gas liquids (NGL), whereby the organic contaminants from the particulate solids are dissolved in the extraction agent to form a single phase solution;
  - b) said solution containing the extraction agent and nonpolar organic contaminants may be conveyed to a production flow-line; or may not be quantitatively conveyed to a production flow-line;
  - c) and the clean particulate solids are discarded.
2. Process in accordance with claim 1, characterised in that the extraction agent is a condensate collected from a production flow-line in the form of natural gas liquid.
3. Process in accordance with claim 2, characterised in that said non-polar contaminants may not be quantitatively conveyed to a production flow-line.
4. Process in accordance with the claims 1-3, characterised in that the cleaned particulate solids contains less than 1% by weight of organic non-polar contaminants.
5. Process in accordance with the claims 1-4, characterised in that the cleaned particulate solids contains less than 0.5% by weight of organic non-polar contaminants.
6. Process in accordance with the claims 1 -5, characterised in that said particulate solids comprise drill cuttings.

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7. Process in accordance with the claims 1 -6, characterised in that said particulate solids comprise sand.
8. Process in accordance with the claims 1 - 5, characterised in that  
5 said particulate solids comprise sand.
9. Apparatus for removing nonpolar organic contaminants from drill cuttings by contacting said contaminated drill cuttings (6) with an extractant (1) to form a solution of said extractant and said contaminants,  
10 characterised in that:
- means for discarding clean drill cuttings after said contacting;
  - means for conveying said solution to a flow production line.
10. Use of natural gas liquid according to claim 9, where natural gas liquid is ob-  
15 tained from the production flow-line of oil and gas producing facilities.

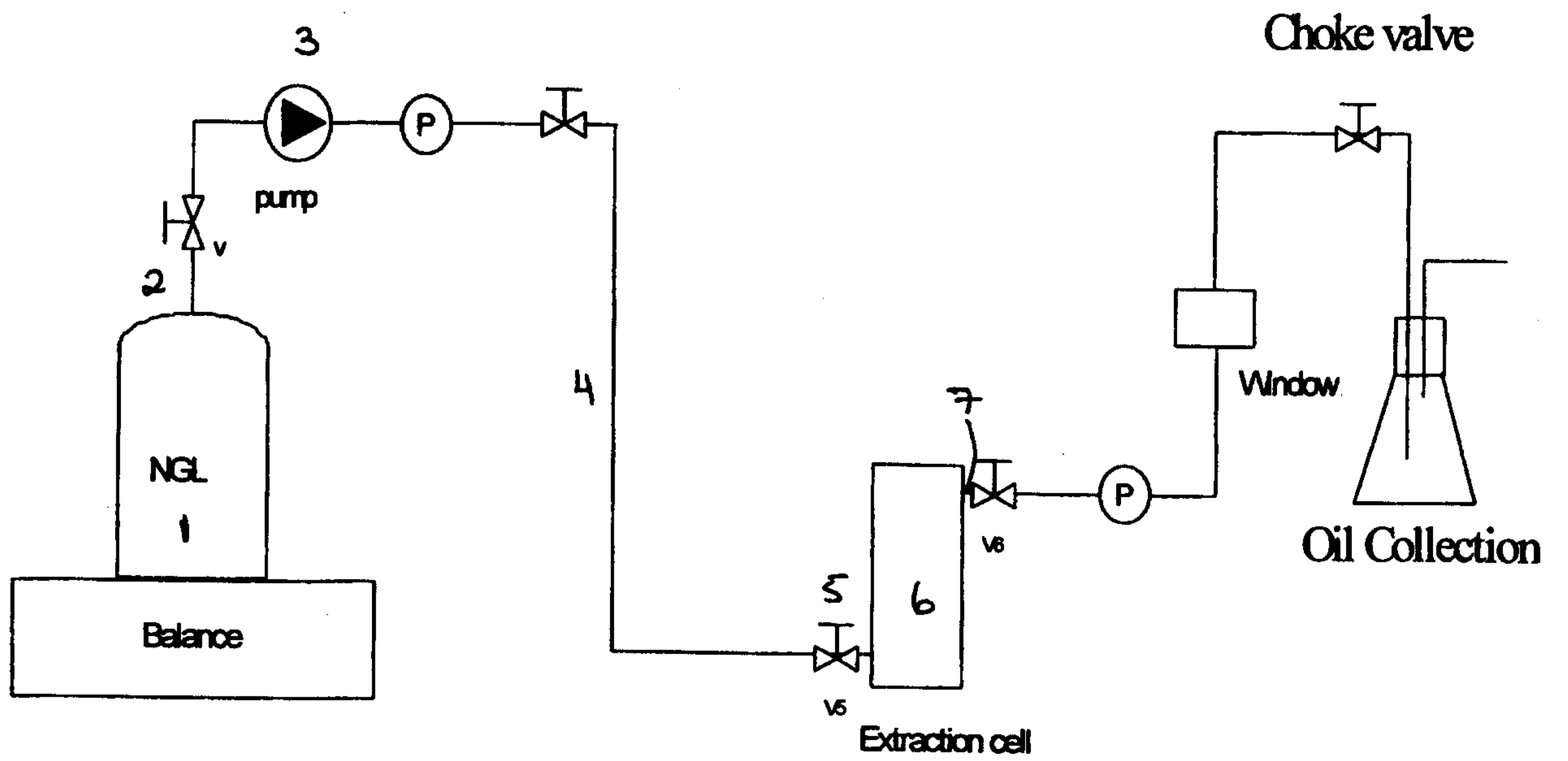


Figure 1: Experimental set-up

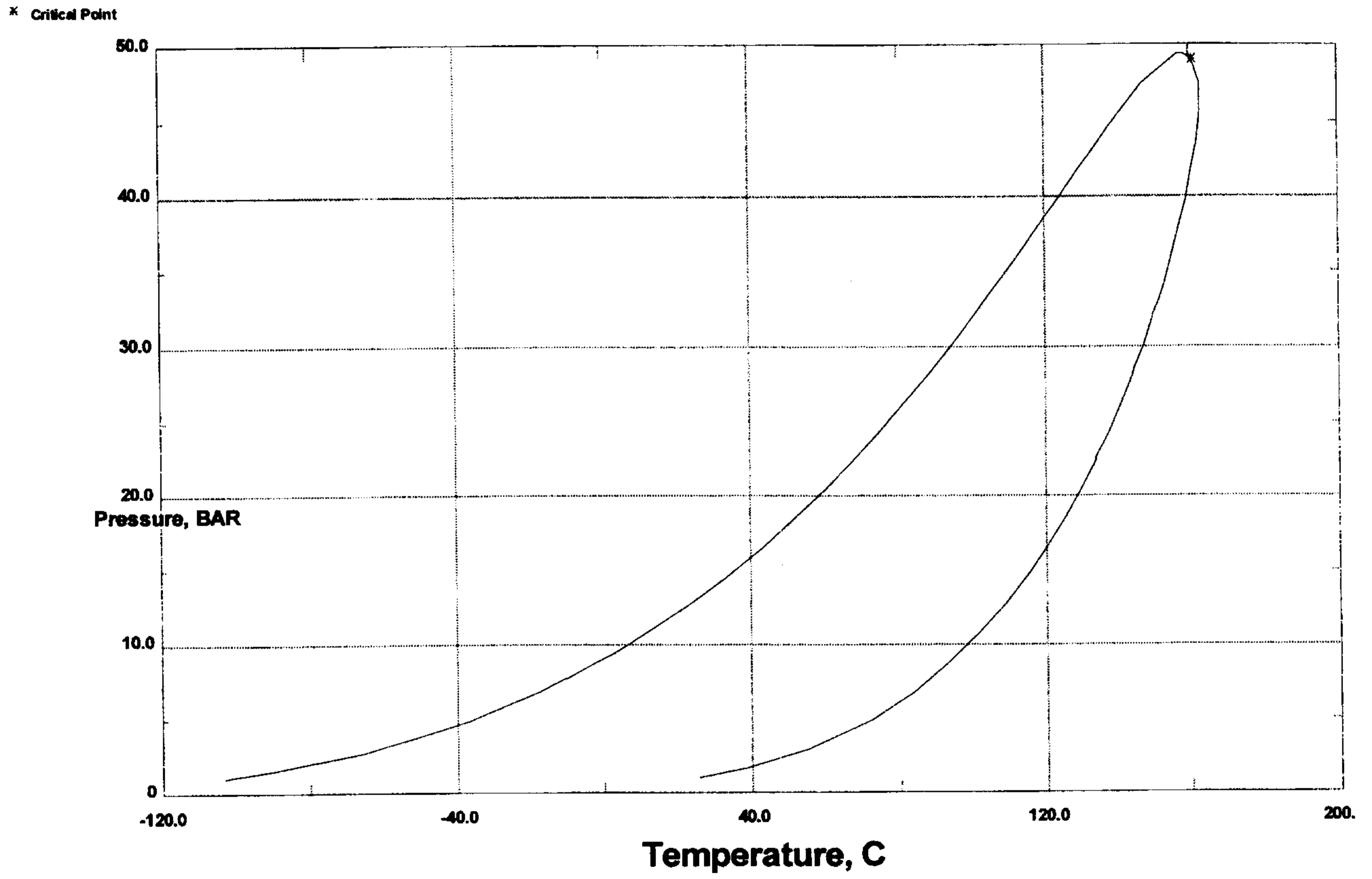


Figure 2: Phase Diagram

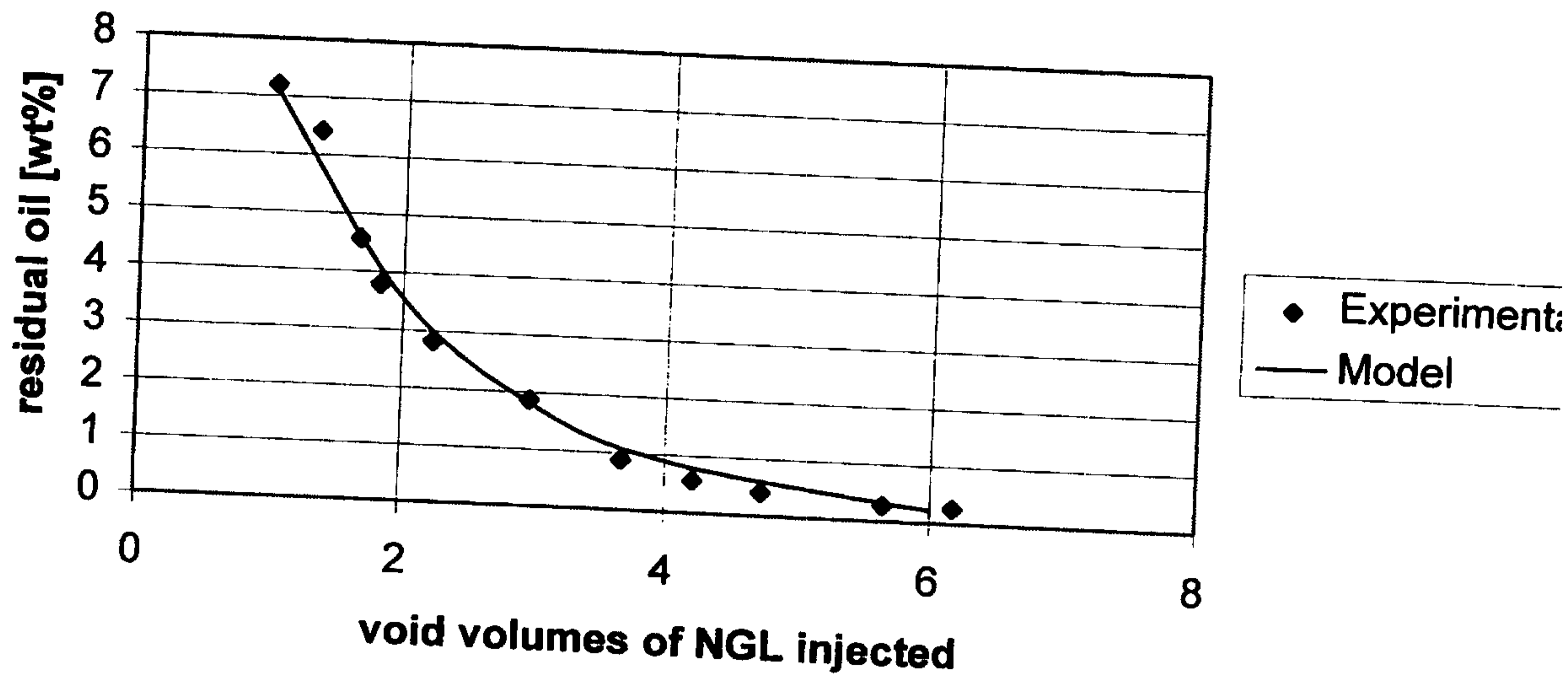


Figure 3: Extraction of oil from drillcuttings.  
Residual oil (related to wet soil) vs void volumes of NGL

