[redacted] PR-12-84

PARTICLE SIZE ANALYSES IN

COMPLETION [redacted]

International Drilling ...

WELL SUMMARY

[redacted]

PARTICLE SIZE ANALYSES IN
COMPLETION BRINES

WELL SUMMARY

NORSKE SHELL A.S.

WELL NO: 31/2-5

MARCH - APRIL 1984

PARTICLE SIZE ANALYSIS

IN

COMPLETION BRINES.

FOR

NORSKE SHELL A.S.

WELL: 31/2-5

MARCH - APRIL 1984

CONTENTS

CONCLUSIONS AND RECOMMENDTAIONS

The operation to analyse the particle content of the brine in well 31/2-5 was undertaken and completed in a sound and detailed manner with a totally successful outcome. At all times the representatives of Norske Shell were presented with the information gained from the analysis (verbally and graphically) and were kept advised of the effectiveness of the filtering operation as shown by the analysis.

The resultant graphs and analysis show the clear trends of particle removal during circulation through the filtration equipment and thus firmly emphasise the advantages of using the type of instrumentation operated on this well.

Therefore it is recommended that the particle analysis instrumentation and engineers of I.D.F are used during similar operations where the purity of a completion brine is of eminent importance.

WELL HISTORY

Name:	31/2-5
Operator:	Norske Shell
Drilled:	October 1980 - December 1981
Contractor:	West Adventure
Casing Depth:	30" @ 436 M
	20" @ 803 M
	13-3/8" @ 1463 M
	9-5/8" @ 1795 M
	Plugged and Abandoned

The well was re-entered for the purpose of testing by BORGNY DOLPHIN between June 1981 and July 1981 when it was again plugged and abandoned. The current objective is to re-enter once more with BORGNY DOLPHIN in order to test a zone between 1591 M and 1594 M, in March and April 1984.

OBJECTIVES OF ANALYSIS AND INSTRUMENTION

The cleanliness of a brine is of paramount importance in order to minimise formation damage by solids contamination and give accurate results during production testing. The particle content of a brine can be analysed by looking at both the number of particles and the size distribution of these particles. By continuously monitoring the brine with a COULTER COUNTER and TURBIDITY METER while circulating, it is possible to determine how clean the brine is, going into and coming out of the well and also the efficiency of the filtration equipment used to clean the brine while circulating.

The TURBIDITY METER will give a qualitative indication of the number of particles in the brine. This method measures the change in intensity of a light source after passing through a cell containing a sample of brine. Any difference in light intensity between the source and the end measurement is an indication of the reduction in intensity due to interference by particles dispersed in the brine. The turbidity of a sample is expressed in Nephelometric Turbidity Units (N.T.U.).

The size distribution and a qualitative indication of the number of particles in a brine can be measured by the COULTER COUNTER. The brine sample is mixed in an electrolyte solution and the particles are drawn by vacuum through a small aperture in an insulating barrier between two electrodes, between which a small electric current flows. As each particle traverses the aperture it momentarily increases the resistance between the electrodes and this electric modulation is sensed as a voltage pulse, proportional to the size of the particle. By altering the sensitivity of the instrument it is possible to select a particle size below which, particles are not counted, thus building up a distribution starting from a count of the largest particles and finishing with the smallest size that the instrument can be calibrated for. The pulses at these selected sizes are recorded on a digital counter and then analaysed for size distribution.

METHOD OF ANALYSIS

The TURBIDITY METER was calibrated to it's maximum reading of a scale 0 - 100 N.T.U. as most of the readings taken were in the 10 - 100 N.T.U. range.

The COULTER COUNTER was operated with an orifice aperture diameter of 70 µm giving a measurable size range of 42 µm to 1.7 µm. The clean electrolyte used was a mixture of 70:30 distilled water and brine and this was filtered down to 0.45 µm (twice) to remove as many background partciles as possible.

A constant dilution of 3.0 ml of brine sample in 100 ml of clean electrolyte was used at each measurement in order to give an indication of the efficiency of the cleaning process as the circulations progressed. Although different dilutions give the same size distributions for a given sample, a change in the concentration of brine sample in electrolyte will give a change in the count at each particle size measured e.g. 2.0 ml of brine in 100 ml of electrolyte will give approximately twice the count at all size levels, that 1.0 ml of the same brine sample in 100 ml of electrolyte would give. Thus a constant dilution can give both the particle size distribution and a qualitative indication of cleaning efficiency, against time.

The sizes studied during each analysis were 19.8 µm or greater, 10.1 µm or greater, 5.1 µm or greater and at the most sensitive setting of 1.7 µm or greater, giving the maximum particle count. A count was recorded for each size range and the size distribution was calculated as being the proprotion/percentage of particles at each size out of the maximum count of 1.7 µm. This method of particle count/number analysis results in a similar but much quicker calculation for size distribution than the more complicated method of particle volume analysis and is more suited to the immediate needs of analysis while circulating.

RESULTS AND GRAPHS

1. This involved a sea-water circulation to clean the well before the initial displacement to brine. The minimum turbidity reading obtained was 17 N.T.U. with 3.1% of the particles being greater or equal to 5.1 µm. It was decided that a small acid clean-up could aid in removing some of the scale and so this was performed followed by a viscous pill.

2. This was a secondary sea-water circulation to continue cleaning the well before displacement to brine. The minimum turbidity reading obtained was 12 + N.T.U. with 4.5% of the particles greater than or equal to 5.1 µm and no further improvement was observed.

3. The well was displaced to brine and circulation continued with the brine returns from the well being filtered before being re-circulated. The filters used were 10 µm size and also 2 µm size (nominal). The resulting graph clearly shows the decreasing turbidity as the filters remove the larger particles and also the close relationship between maximum particle count and turbidity. During filtration the output from the filters gave readings of 0.4 N.T.U. with no particles greater than 10.1 µm.

4. This graph shows the results of a short circulation through the perforation string to clean it and the glass disc in the ported sub. The volume circulated was only sufficient to displace the volume of 9-5/8" casing and so all samples taken at the flow-line were those from the riser which appeared to cause a rust-coloured turbidity and scale during all operations.

5. The circulation depicted in this graph is that carried out just before the gravel pack and after a short reverse circulation to displace the chalk pill used to bullhead out diesel in the string. The initial returns are those of the clean brine used in the reverse circulation. There follows a volume of very dirty brine which corresponds to that which occupied the riser, being rust-coloured and contaminated with scale. The clean brine following is from the 9-5/8" casing and proceeding this is the return from the bottom of the hole which contains a large proportion of formation oil. Finally clean, filtered brine returns are samples which slowly become cleaner from the filtering process.

Results And Graphs (Cont'd)

5. However, after adding some concentrated acid to half a sample and comparing it's turbidity and particle distribution to the un-acidised half, it was seen that most of the particles corresponded to very fine acid-soluble particles of chalk from the earlier bullhead operation. It was decided that no further effective filtration could be attained and circulation was ended.

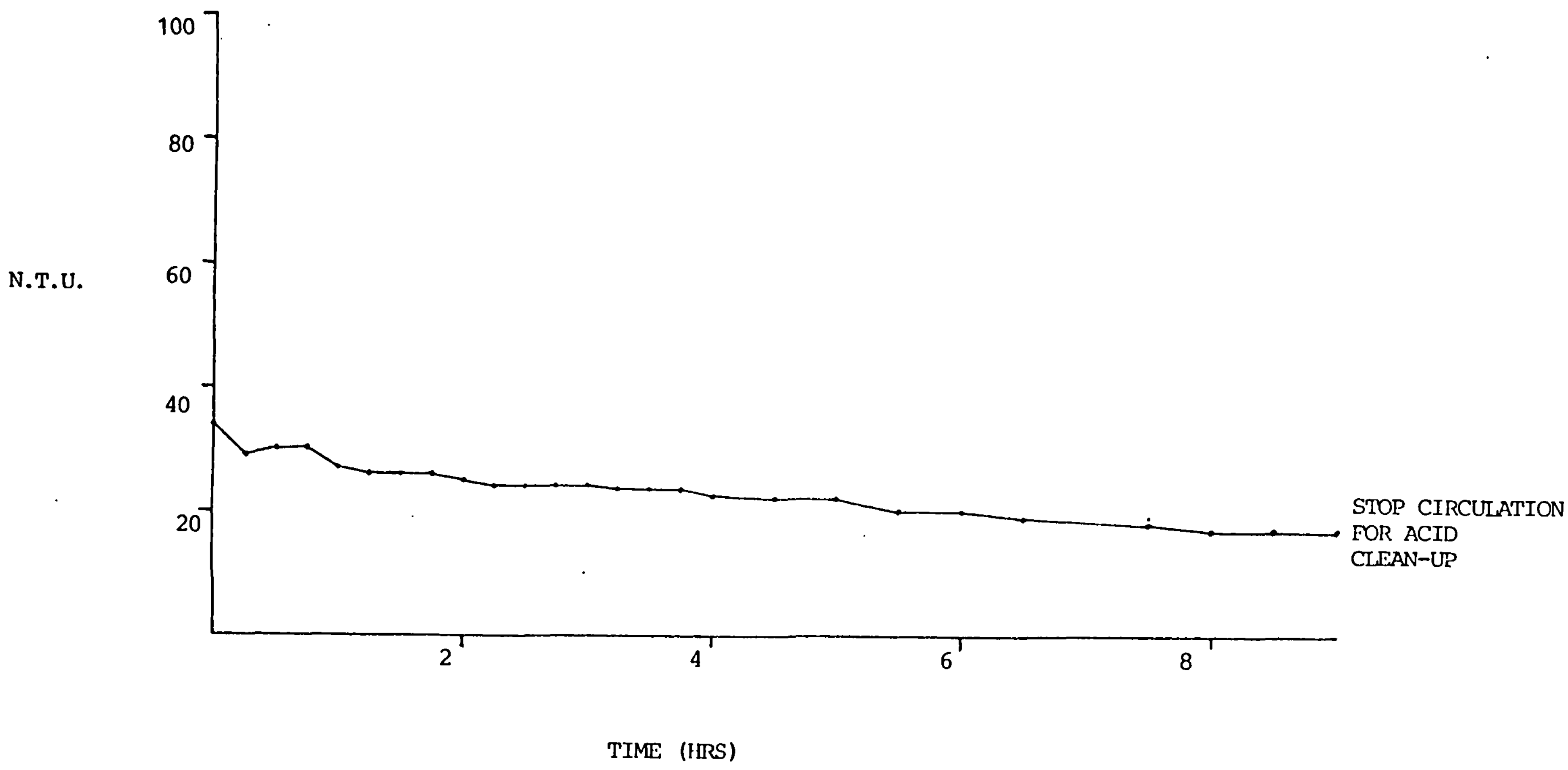
6. The final circulation was carried out before production testing commenced. It displaced the complete volume of the well and stopped when clean brine returns were sampled.

NOTE:

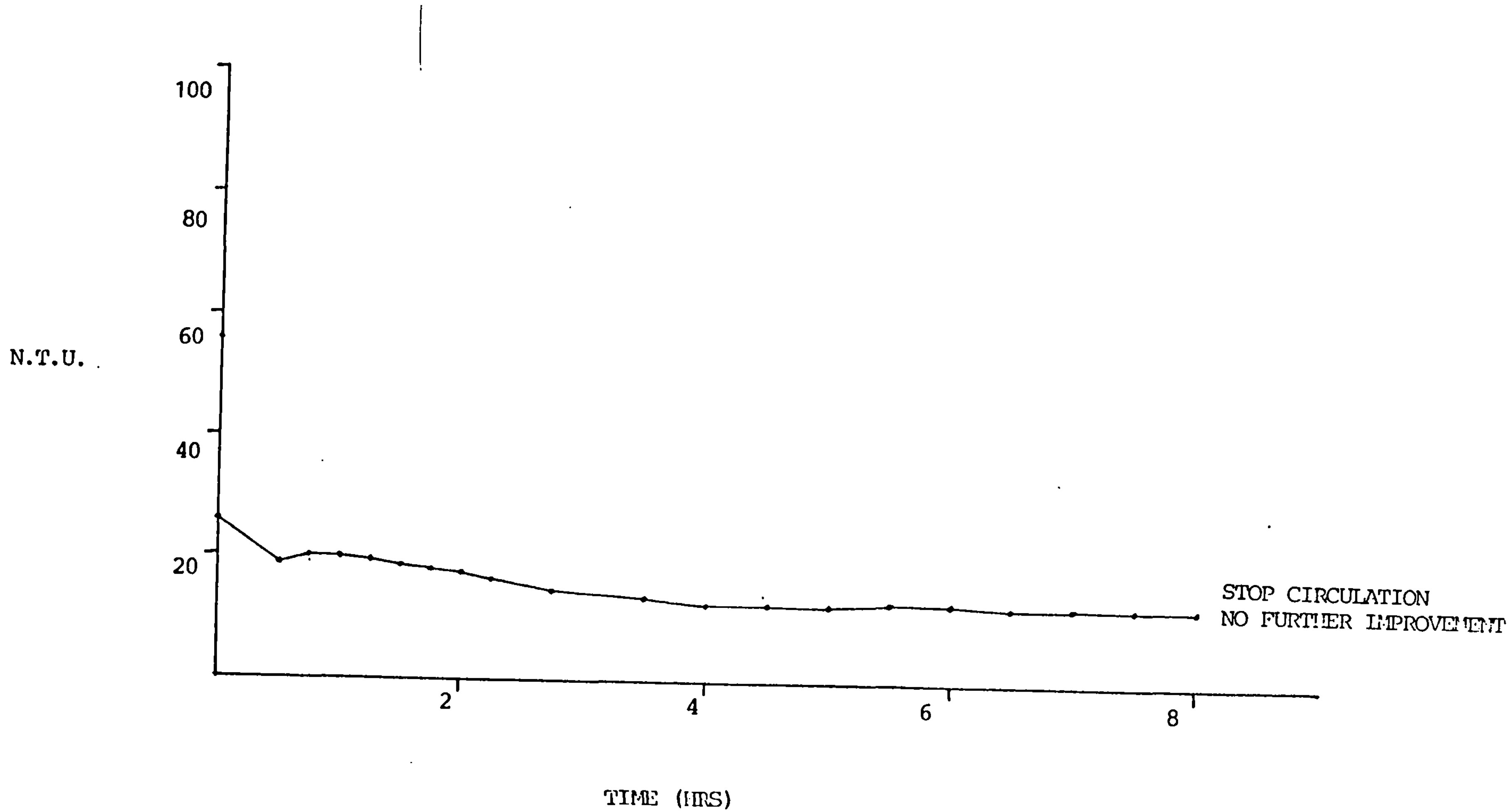
For the purpose of clarity in the summary the results and graphs have been based on samples taken from the flow line. However, samples were taken from the outlet of the filtration equipment, in order to estimate it's efficiency and the results largely showed turbidity of less than 1 N.T.U. with only a negligible number of particles of greater size than 5.1 μm. This treated brine was subsequently circulated down-hole.

It is therefore reasonable to believe that the brine at the zone to be tested was of a similar nature and that the brine tested at the flow line contained solids accumulated from circulation in the other part of the well.

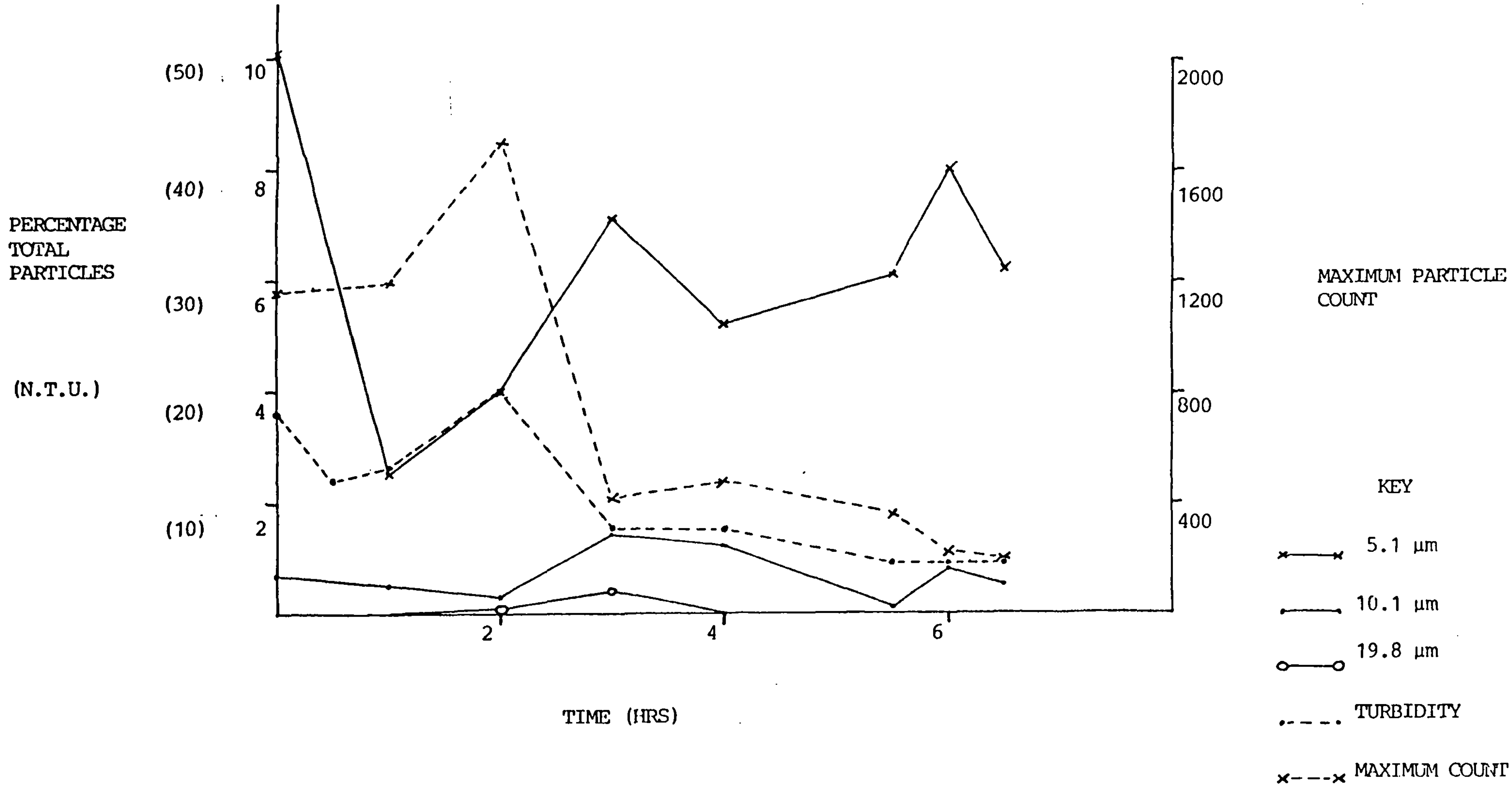
1. SEA-WATER CIRCULATION



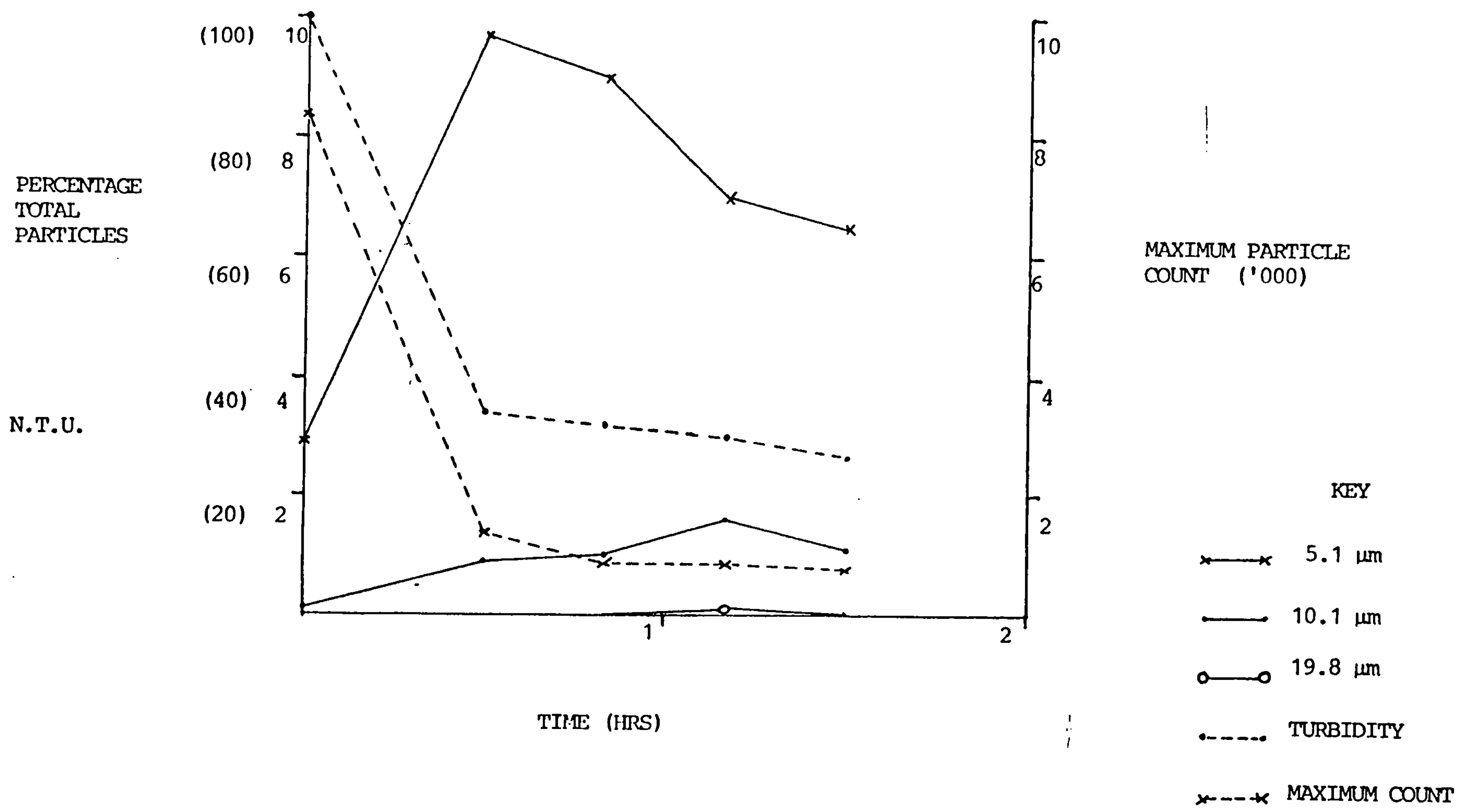
2. SECONDARY SEA-WATER CIRCULATION



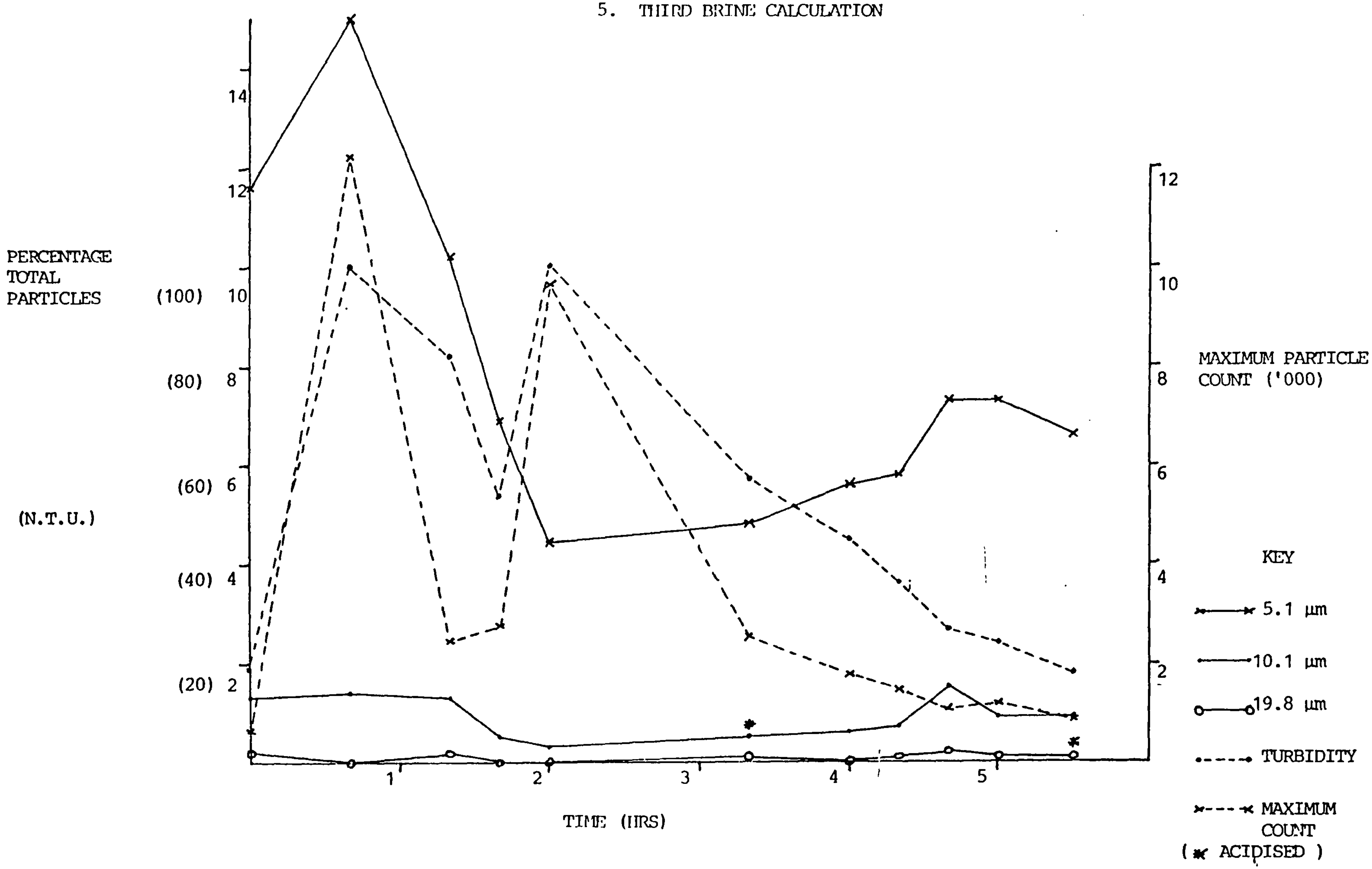
3. FIRST BRINE CIRCULATION



4. SECOND BRINE CIRCULATION



5. THIRD BRINE CALCULATION



6. FOURTH BRINE CIRCULATION