NORSK HYDRO GEOLOGISTS

1758

Milchem®

Drilling Fluids

COPY

MUD PROGRAM

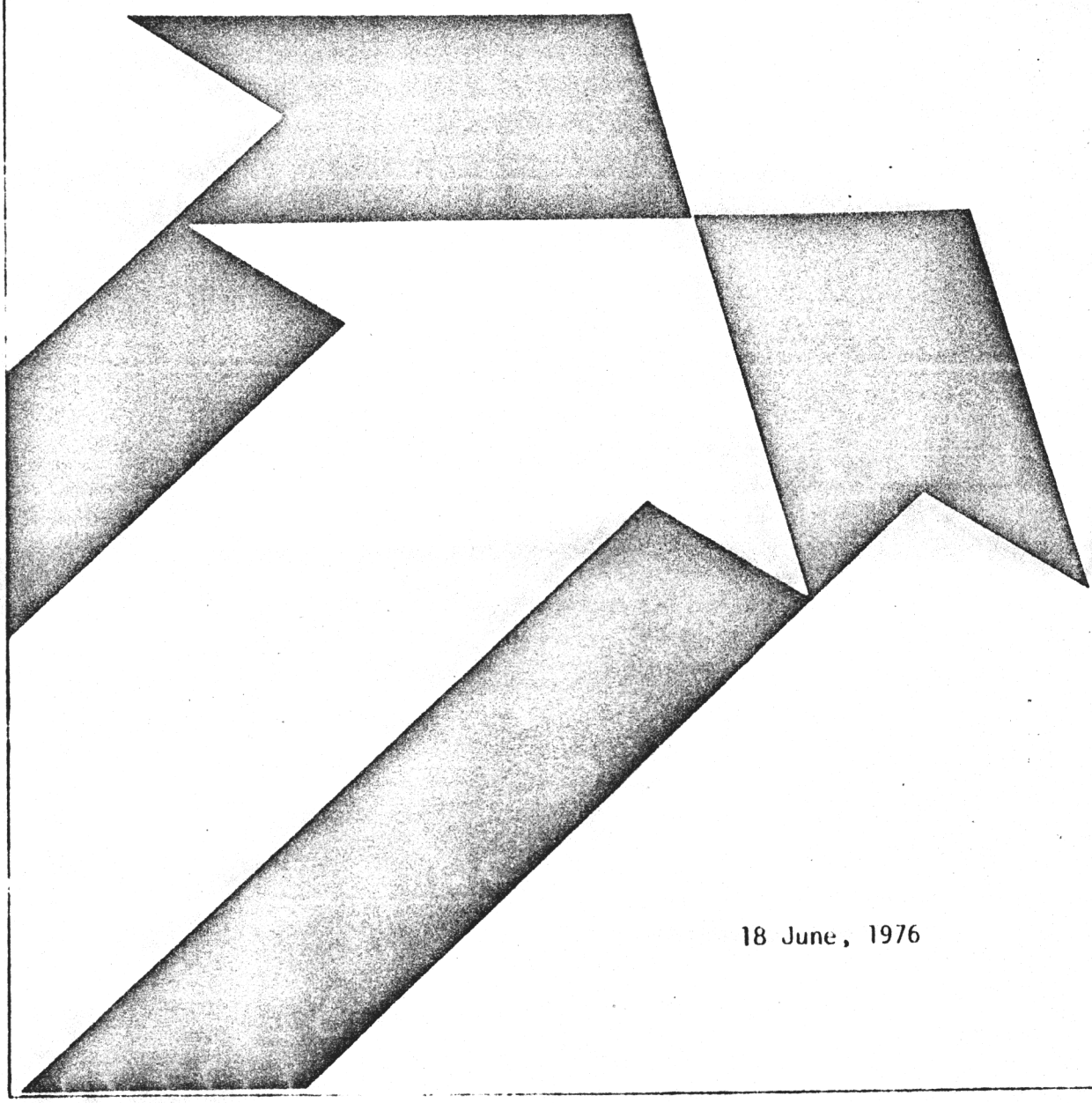
NORSK HYDRO

30/7-3

Milchem

DRILLING FLUIDS

PROPOSED MUD PROGRAM



18 June, 1976

COMPANY Norsk Hydro WELL NO. 30/7-3 AREA North Sea COUNTRY Norway

Milchem®

Drilling Fluids Division

Drilling Fluid Recommendations

Date 18 JUNE, 1976

Prepared for Mr. Jake McBride Company Norsk Hydro

Address Bygdøy Alle 2, Oslo Norway

Well Name 30/7-3 Proposed Depth 4100 meters

Location North Sea County ____ State Norway

Max. temp 220-225°F

CASING PROGRAM

20 in. @ 700 meters (Surface) 13 3/8 in. @ 2800 meters (Intermediate) 9 5/8 in @ 3900 meters (Other)

RECOMMENDED DRILLING FLUID PROPERTIES

Depth ft	Mud Weight ppg	Viscosity sec/qt	API Filtrate ml	PV - YP	Ph	Mud Type
R.K.B. - 183 m.	Native	27				Sea Water
R.K.B. - 183 m.	8.6	125 - 150	+- 30.0	40 - 30	8.5	Slug Mud
183 - 700 m.	8.8	70 - 90	+- 25.0	30 - 30	8.5	Spud Mud §
700 - 2800 m.	9.5	45 - 60	8.0 - 12.0	15 - 20	9.0	Bentonite Lignosulfon. C.M.C. §
2800 - 3900 m.	14.0	45 - 55	4.0 - 8.8	25 - 15	9.0	Bentonite Lignosulfon. CMC Lignite Low Salt H_2C
3900 - 4100 m.	16.7	45 - 55	3.0 - 5.0	45 - 16	9.0	Bentonite Lignosulfon. Lignite Soltex Fresh Water

RECOMMEND 2-4 PPB Milgard for H_2S Protection in this interval.

§ = SEA WATER

Estimated Drilling Fluid Cost $ 252,304.41

Estimated Days 100

Possible Drilling Problems:

POSSIBLE HYDROGEN SULFIDE IN LOWER SECTION OF THIS HOLE:

References:

Prepared by District Office Warehouse

Bill Mackee — Title Area Engineer

Stavanger Norway — Telephone: A/C 045-96677

Tananger / Bergen — Telephone: A/C 045-96465 / 05-216680 Ext.186

TSD-DFR 2 6 69

Indemnity Clause On Reverse Side

Drilling Fluids Division

Drilling Fluid Recommendations

PROPOSE TO USE A LIGNOSULFONATE-BENTONITE MUD FOR WELL NO. 30/7-3

Phase 1 RKB - 183m. 36" Hole

All Bentonite used in this well will be prehydrated or Q-mixed and aged for 24 hours if possible. Add 1 ppb Caustic to fresh water before prehydrating. Upon arriving on location mix 1200 barrels of high viscosity mud with a vis. of about 125-150 sec/qt.

Drill 36" hole with sea water and pump 100 barrels slugs around as needed. 200 barrels will be required to fill the 36" hole to the sea bed. Before running 30" casing flush hole with about 400 bbls of high vis. mud to clean hole, this will give about a 100% extra slug. Be sure that the pill is heavier than sea water or it will float and the hole will displace with sea water. Pill weight should be at least 8.7 ppg.

Phase 11 183m. to 700m. 26" Hole

Drill 26" hole with existing spud mud. Reduce vis. to about 70-90 sec/qt. Spot 125 vis. pill in open hole before trying to run 20" casing. Use same procedure as in Phase 1 but do not try to drill with sea water. Circulate at least two circulations and spot a high vis. pill in uncased hole before running 20" casing. Some Flosal may be required and a little reg. Drispac will give a fast and high viscosity if required. Drill this section with sea water - Bentonite - Caustic.

Phase 111 700m. to 2800m. 17 1/2" Hole

Reduce screen size on shakers but still be able to handle entire circulating volume. Use CMC and Lignosulfonate to control filtrate and viscosity. Raise mud weight to 9.5 ppg before reaching 13-3/8" casing depth. Control wt. with sea water.

Phase 1V 2800m. to 3900m. 12 1/4" Hole

Use the same mud as in Phase 111 to drill to 12,468'. Be sure the sand trap and the settling trap is cleaned while running 13-3/8" casing. After drilling out of 13-3/8" casing, raise mud wt. as required to 13.5 ppg. Check out all drilling fluid controls and make sure they are in good order. Change shaker screens to the smallest size that will handle the volume. Some of the formations in this section are sensitive to erosion so try to keep the annular velocity between 120 to 150 fpm. Use Ligcon to keep the HTHP filtrate 15-20 cc at 250^{o}F in the lower part of this section.

CONTINUED

Milchem®
Drilling Fluids

Drilling Fluid Recommendations

PHASE V 8 3/8" Hole from 3900m to 4100m.

Drill thid interval with a fresh water bentonite-lignosulfonate mud treated with lignite to control filtrate. Should excess torque or drag occur, add 1 sack per hour of medium wallnut hulls. DO NOT USE WALLNUT HULLS IF THIS INTERVAL IS TO BE CORED, RUN A DIAMOND BIT OR IF A TURBINE IS TO BE USED. Should any of the cases above apply, add 3-4 PPB of soltex. Make sure that all solids control equipment is working properly.

MAINTAIN A CLOSE AND CONSTANT WATCH FOR H_2S (Hydrogen Sulfide).

FORMULA FOR MIXING PREHYDRATED BENTONITE:

Mix in the following order:
1 bbl of fresh water:
25 ppb - 35 ppb Wyoming Bentonite
1/4 ppb of Caustic Soda
2 ppb Lignosulfonate
1/4 ppb Desco
15-25 more ppb Wyoming Bentonite

There is no need to prehydrate Bentonite in PHASE V

Milchem®
Drilling Fluids Division

Company Norsk Hydro A/S Location
Well Name 30/7-3 Survey
County North Sea State Norway
Date

MUD SPECIFICATIONS				CASING	FORMATION
Depth ft	Mud Weight ppg	Viscosity sec/qt	API Filtrate ml	METERS from RKB	
Drill 36" hole with sea water. Before running 30" fill hole to sea bed with high viscosity mud plus 25% extra volume to flush hole. The mud weight of this fluid should be greater than sea water, otherwise the slug will float. All bentonite used will be prehydrated and Q-mixed if possible (for instructions on Q-mix see page 1). RKB-183 meters	native	120-150 sec/qt	Unc.	30" CASING 250 500	Phase 1 36" hole
Use all available mud recovered from Phase 1. Phase 11 can be drilled with a non dispersed mud. All available solids control (Desander, Desilter) should be used in this interval. Drill with sea water. 183 to 700 meters	9.0 ppg	70-80 sec/qt	Unc.	20" CASING 750 1000 1250	Phase 11 26" hole
Dilute existing mud back to 45-60 sec/qt. Drill with non dispersed mud to about 5000'. Condition mud to the specifications below by 7000'. Drill with sea water. 700 to 2800 meters	9.5 ppg	45-60 sec/qt	8-12 cc	1500 1750 2000	Phase 111 17½" hole
				2250 2500	

See page 2

TSD DFR 8-11 70

Indemnity Clause On Reverse Side

Milchem®
Drilling Fluids Division

Company Norsk Hydro A/S Location
Well Name 30/7-3 Survey
County North Sea State Norway Date

MUD SPECIFICATIONS				CASING	FORMATION
Depth ft	Mud Weight ppg	Viscosity sec/qt	API Filtrate ml		
Drill out of 13-3/8" casing with 13.5 ppg mud. Begin additions of Lignite for filtration control. Drill with Fresh water. Reduce CL to 8,000 ppm prior to weighting up.				2750 13 3/8" CASING	Phase IV
2800 to 3900 meters	13.5	45-55	HTHP (15-20 cc) 4-8 cc	3000	
Drill out of 9-5/8" with 16.7 ppg mud wt. Temperature not in excess of 350°F is anticipated in this interval. Maintain CEC at 25 ppg. Before logging and running 7" liner, increase viscosity to 70-80 sec/qt with Bentonite spot high viscosity mud in open hole. If adverse torque or drag occurs use 4-6 ppg Soltex.				3250 3500 3750 9 5/8" CASING 4000 4250	T.D. Phase V
3900 to 4100 meters	16.7	45-55	HTHP (8-12 cc) 3-5 cc API		

TSD DFR-8 11 70

Indemnity Clause On Reverse Side

Milchem®
Drilling Fluids

Operator: Norsk Hydro A/S
Well Name & No.: 30/7-3
County: North Sea State: Norway

INTERVAL, ft.
RKB - 183 m
PHASE: I

ANTICIPATED

Drill 36" hole with sea water. Before running 30" fill hole to sea bed with high viscosity mud plus 25% extra volume to flush hole. The mud weight of this fluid should be greater than sea water, otherwise the slug will float. All Bentonite used will be prehydrated. Q-mixed of possible. (For instructions on Q-mix see page 1).

Mud Weight	Filtrate	Viscosity	Shaker	Cent	De-silter	Volume	Hole Size	Circ. Res.	Steel Pits	Log or Test
	Unc.	125/150				1200	36"			

ACTUAL

This interval should require 600 bbls of the above.

* CODE	PROJECTED Cost	PROJECTED Units	MATERIAL	PRICING UNIT	ACTUAL Units	ACTUAL Cost
	$ 4320.00	400	Wyoming Bentonite	$ 10.80		
	593.00	20	Caustic Soda	29.65		
	1437.00	100	Lignosulfonate	14.37		
			Cost for this interval will be approximately	$ 3300.00.		

*CODE: S Spud I Initial W Weight Increase M Maintenance U Unanticipated

Mud Cost Analysis

This Phase

PROJECTED

$ Cost	Days
6,350.00	2

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT
$

COST PER DAY
$

Cumulative

PROJECTED

$ Cost	Days
6,350.00	2

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT
$

COST PER DAY
$

Milchem®
Drilling Fluids

Operator: Norsk Hydro A/S
Well Name & No.: 30/7-3
County: North Sea State: Norway

INTERVAL, ft.
183 m - 700 m
PHASE: 11

ANTICIPATED

Use existing spud mud to start this interval. This interval can be drilled with a nondispersed mud using prehydrated Benonite as a viscosifier (Q-mix). When possible allow prehydrated Bentonite to age for at least 24 hrs. to obtain maximum yield. Maximum use of all available solids control equipment should be used in this interval. Before running 20" casing raise viscosity to 100-200 sec/qt. Maintain 500 bbls of high viscosity slug mud in reserve.

Mud Weight	Filtrate	Viscosity	Shaker	Cent.	De-silter	Volume	Hole Size	Circ. Res.	Steel Pits	Log or Test
-	-	70-90				1600	26			

ACTUAL

* CODE	PROJECTED Cost	PROJECTED Units	MATERIAL	PRICING UNIT	ACTUAL Units	ACTUAL Cost
	$ 4320.00	400	Wyoming Bentonite	$ 10.80		
	1482.50	50	Caustic	29.65		
	1221.45	85	Lignosulfonate	14.37		

*CODE: S Spud I Initial W Weight Increase M Maintenance U Unanticipated

Mud Cost Analysis

This Phase

PROJECTED

$ Cost	Days
7,023.95	3

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT
$

COST PER DAY
$

Cumulative

PROJECTED

$ Cost	Days
13,373.95	5

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT
$

COST PER DAY
$

Mudchem® Drilling Fluids

Operator: Norsk Hydro A/S

Well Name & No.: 30/7-3

County: North Sea State: Norway

INTERVAL, ft.: 700 m - 2800 m

PHASE: III

ANTICIPATED

Drill out of 20" casing using mud from Phase II. This interval can be drilled to about 5000' using a non-dispersed mud. Add Barite to increase to 9.5 ppg. Start treating flow properties and water loss below 5000'. Filtrate should be 12 cc or less to 8000'. Maintain solids 10% or less using solids control equipment.

PV - 10

YP - 15 = 20 to run logs

Mud Weight	Filtrate	Viscosity	Shaker	Cent.	De-silter	Volume	Hole Size	Circ. Res.	Steel Pits	Log or Test
9.5	8-12	45-60				2050	17½			

ACTUAL

Some shales in this interval are sensitive to hydroxal ions. Try to maintain a 9.5 Ph or less.

* CODE	PROJECTED Cost	PROJECTED Units	MATERIAL	PRICING UNIT	ACTUAL Units	ACTUAL Cost
	$ 14968.80	1386	Bentonite	$ 10.80		
	11207.70	378	Caustic	29.65		
	6095.22	113	C.M.C. reg.	53.94		
	480.50	5	Defoamer	96.10		
	3510.36	252	Med. Walnut	13.93		
	7242.48	504	Lignosulfonate	14.37		

*CODE: S - Spud I - Initial W - Weight Increase M - Maintenance U - Unanticipated

Mud Cost Analysis

This Phase

PROJECTED

$ Cost	Days
43,505.06	32

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT $

COST PER DAY $

Cumulative

PROJECTED

$ Cost	Days
56,879.01	37

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT $

COST PER DAY $

Milchem® Drilling Fluids

Operator: Norsk Hydro A/S

Well Name & No.: 30/7-3

County: North Sea State: Norway

INTERVAL, ft.: 2800 m - 3900 m

PHASE: IV

ANTICIPATED

Drill out of 13 3/8" casing with existing mud as follows:

Gradually increase wt from 10.0 to 14.0 by 3500 m. Reduce chlorides by 3560 m to 8000 ppm. Before running logs allow YP to rise to 15-20. Drill 12 1/4" hole using Fresh water.

Mud wt	- 14.0 ppg	HTHP	- 15-20 cc
Vis	- 45-55	Solids	- 27-30
Filtrate	- 4-8 cc	CEC	- 25
PH	- 9.0	Anular Velocity	- 120-150 FPM
PV	- 20-35		
YP	- 12-15		

Mud Weight	Filtrate	Viscosity	Shaker	Cent.	De-silter	Volume	Hole Size	Circ. Res.	Steel Pits	Log or Test
14.0	4-8 cc	45-55	60x40			600	12-1/4			

ACTUAL

* CODE	PROJECTED Cost	PROJECTED Units	MATERIAL	PRICING UNIT	ACTUAL Units	ACTUAL Cost
	$ 5443.20	504	Bentonite	$ 10.80		
	11207.70	378	Caustic	29.65		
	13592.88	252	C.M.C.	53.94		
	10059.00	700	Lignosulfonate	14.37		
	1755.18	126	Med. Walnut Hulls	13.93		
	3273.48	252	Mica Fine	12.99		
	10742.76	756	Lignite	14.21		
	56480.00	500mt	Barite	112.96		

*CODE: S Spud I Initial W Weight Increase M Maintenance U Unanticipated

Mud Cost Analysis

This Phase

PROJECTED

$ Cost	Days
112,554.20	31

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT $

COST PER DAY $

Cumulative

PROJECTED

$ Cost	Days

ACTUAL

$ Cost	Days
169,433.21	67

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT $

COST PER DAY $

Milchem®
Drilling Fluids

Operator: Norsk Hydro A/S
Well Name & No.: 30/7-3
County: North Sea State: Norway

INTERVAL, ft.: 3900 m - 4100 m
PHASE: V

ANTICIPATED

Tempertures not in excess of 350°F should be encountered in this interval. Drill this interval with mud treated to the approximate specification below. If excess torque or drag occurs recommend 4-6 ppb Soltex.

Mud wt.	- 16.7 ppg	Solids	- 38-40%
Vis.	- 45-55	CEC	- 125
Filtrate	- 3-5 cc	HTHP	- 8-12 cc
PH	- 9.0 - 9.5	Anular Velosity	- 120-150 FPM
PV	- 45-50		
YP	- 16-20		

H_2S may be encountered in this well.

Mud Weight	Filtrate	Viscosity	Shaker	Cent.	De-silter	Volume	Hole Size	Circ. Res.	Steel Pits	Log or Test
16.7	3-5 cc	45-55	60x80			400	8-3/8"			

ACTUAL

Look out for temp. increase - abnormal pressure

* CODE	PROJECTED Cost	PROJECTED Units	MATERIAL	PRICING UNIT	ACTUAL Units	ACTUAL Cost
	$ 2721.60	252	Bentonite	$ 10.80		
	14943.60	504	Caustic	29.65		
	11496.00	800	Lignosulfonate	14.37		
	8526.00	600	Lignite	14.21		
	45184.00	400mt	Barite	112.96		

*CODE: S - Sould I - Initial W - Weight Increase M - Maintenance U - Unanticipated

Mud Cost Analysis

This Phase

PROJECTED

$ Cost	Days
82,871.20	40

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT
$

COST PER DAY
$

Cumulative

PROJECTED

$ Cost	Days
252,304.41	107

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT
$

COST PER DAY
$

Drilling Fluids

Operator: Norsk Hydro A/S

Well Name & No.: 30/7-3

County: North Sea State: Norway

INTERVAL, ft.

PHASE:

ANTICIPATED

Should an inhibited system be necessary in the first 4 phases of this well, (Gyp-Lignosulfonate) the materials listed below will be needed in addition to the materials listed in the recommended mud program.

Mud Weight	Filtrate	Viscosity	Shaker	Cent.	De-silter	Volume	Hole Size	Circ. Res.	Steel Pits	Log or Test

ACTUAL

* CODE	PROJECTED Cost	PROJECTED Units	MATERIAL	PRICING UNIT	ACTUAL Units	ACTUAL Cost
	$ 6240.00	1200	Gypsum			
	5930.00	200	Caustic			
	5748.00	100	Lignosulfonate			
	$ 17918.00					

*CODE: S Spud I Initial W Weight Increase M Maintenance U Unanticipated

Mud Cost Analysis

This Phase

PROJECTED

$ Cost	Days

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT

$

COST PER DAY

$

Cumulative

PROJECTED

$ Cost	Days

ACTUAL

$ Cost	Days

DIFFERENCE ____ %

$ Cost	Days

COST PER FOOT

$

COST PER DAY

$

Milchem®
Drilling Fluids Division

Drilling Fluid Recommendations

To convert to a Calcium Sulphate (Gyp) Mud:

1. Reduce native solids by dilution with sea water over two or three circulations before break-over to reduce high viscosity.

2. Add 1.0 to 1.5 pounds per barrel Caustic Soda
   Add 2.0 to 6.0 " " " Lignosulfonate
   Add 4.0 to 6.0 " " " Gypsum over two circulations.

Maintenance of the Gup mud will require tourly treatment of Lignosulfonate and Gypsum. Pilot test with CMC and Drispac to determine the correct treatment for filtration control.

The primary control factor is the available unreacted Calcium Sulphate as measured in the mud filtrate. Filtrate Calcium should be maintained from 600 to 1200 parts per million.

The Ph must be maintained between 9.5 and 10.5. If the level of unreacted or free Calcium Sulphate is allowed to drop the mud viscosity will become uncontrollable.

Milchem

Drilling Fluids Division

Operator Norsk Hydro A/S

Well Name & No. 30/7-3

Location North Sea Country Norway

MUD COST SUMMARY

PROJECTED Cost	Units	Material	ACTUAL Units	ACTUAL Cost
$ 31773.60	2942	Wyoming Bentonite		
39434.50	1330	Caustic		
19688.10	365	CMC		
31455.93	2189	Lignosulfonate		
19268.76	1356	Lignite		
101664.00	900mt	Barite		
5265.54	378	Wall Nut Hulls		
3273.48	252	Mica Fine		
480.50	5	Defoamer		
$ 252,304.41		Estimated total materials to drill trouble free well to 13,452', in this area. This includes consideration for the amount of coring expected.		
		We also recommend the following materials be stocked should difficulties arise.		
$ 1322.00	100	Bi Carb		
3650.00	10	Milplate (Lubricants) (55 gal.drum)		
155.64	50	Soda Ash		
26296.00	150	Milgard (H_2S scavanger)		
1558.00	200	Salt Gel.		
385.00	100	Lime		
9062.00	200	Soltex		
$ 42,428.69				
		Engineering Services:		
$ 24,610.00		Estimated 107 days		

Milchem®

Drilling Fluids Division

PRODUCT BULLETIN

MIL-BAR*

DESCRIPTION

A high purity barite, used for increasing the density of all types of drilling fluids. Mil-Bar, which is derived from barium sulfate ($BaSO_4$), has a specific gravity of 4.20 g/ml or better, and is chemically inert to all drilling fluid additives.

APPLICATION

Mil-Bar is applicable to all drilling fluids for purposes of increasing density.

SPECIFICATIONS

Mil-Bar exceeds the following API specifications:

Density, g/ml	4.20 minimum
Soluble Alkaline Earth Metals:	
Parts Ca^{++}/million parts barite	250 maximum
Wet Screen Analysis,	
Retained on U.S. Sieve No. 200	3.0% maximum
Retained on U.S. Sieve No. 325	5.0% mimimum

TECHNICAL DATA

The amount of Mil-Bar needed to increase mud density can be calculated as follows:

$$\text{Bags Mil-Bar/100 barrels of mud} = \frac{1505\ (W_2 - W_1)}{35.8 - W_2}$$

Where: W_1 = Initial Weight
W_2 = Desired Weight

PACKAGING

Mil-Bar is packaged in 100-pound multi-wall bags and is also available in bulk.

* Registered Trademark of Milchem Incorporated

Milchem®

Drilling Fluids Division

PRODUCT BULLETIN

MILGEL®

DESCRIPTION

A premium grade Wyoming bentonite which will yield approximately 100 barrels per ton of 15 centipoise mud in fresh water.

APPLICATION

Milgel is effective for viscosity and fluid loss control. In muds containing chlorides in excess of 20,000 ppm, it is recommended that Milgel be pre-hydrated in fresh water before adding to the brackish mud.

RECOMMENDED TREATMENT

Milgel will result in a 35 to 37 sec/qt funnel viscosity when added to fresh water in concentrations of 20 ppb. While drilling, Milgel is normally added at a rate of 1 to 3 pounds per foot of hole drilled unless bentonitic mud-making shales are being drilled.

PACKAGING

Milgel is packaged in 100-pound multi-wall bags.

Milchem®

Drilling Fluids Division

PRODUCT BULLETIN

SALT WATER GEL®

DESCRIPTION

An attapulgite clay which is an effective viscosifier in water ranging from fresh to salt saturated.

APPLICATION

Salt Water Gel is used to obtain viscosity and gel strengths in saturated or near-saturated brine systems. This product is also utilized in high-solids squeeze plugs for controlling loss of circulation. Viscosity increases with Salt Water Gel are proportional to the rate of shear, and it is recommended that the drilling fluid system be well-agitated in order to obtain maximum yield.

RECOMMENDED TREATMENT

As a viscosifier in brine systems, approximately 15.0 ppb of Salt Water Gel will result in a 15.0 cp mud or a funnel viscosity in the range of 34.0-36.0 sec/qt. Fluid loss control is attained in Salt Water Gel brine systems with Milstarch®.

PACKAGING

Salt Water Gel is packaged in 80-pound multi-wall bags.

RECOMMENDED TREATMENT

* As an inhibited system: 8.0 to 10.0 ppb.
* Deflocculant for seawater muds: 4.0 to 6.0 ppb.
* For temperature stability above 350°F: 8.0 to 10.0 ppb.
* Deflocculant for fresh water muds: 1.0 to 3.0 ppb.

PACKAGING

Uni-Cal is packaged in 50-pound multi-wall bags.

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Milchem®
Drilling Fluids Division

PRODUCT BULLETIN

UNI-CAL™

DESCRIPTION

A multi-purpose, chrome-treated sodium lignosulfonate conditioning agent. Uni-Cal is primarily a deflocculant, but works equally well for control of down-hole filtration rate, and effectively inhibits the chemical activity of clay solids when used in proper concentrations.

APPLICATION

Extremely flexible, Uni-Cal works well in salt, calcium, and fresh water environments. It functions efficiently

* As a deflocculant and down-hole fluid loss control agent, particularly under dynamic conditions.
* As an emulsifier of diesel oil.
* To protect sensitive production zones against clay swelling type damage.
* As a stabilizer of water-base muds at temperatures in excess of 350°F.
* As a deflocculant for seawater muds.

... continued

Milchem®
Drilling Fluids Division

PRODUCT BULLETIN

MILCHEM CMC®

DESCRIPTION

Sodium Carboxymethylcellulose. A long-chain organic colloid which imparts viscosity and reduces fluid loss.

Available in three grades:

High Viscosity (99 percent minimum purity)
Medium Viscosity (99 percent minimum purity)
Technical Grade (72 percent minimum purity)

Milchem CMC is:

Stable at temperatures up to 300° F.
Not subject to bacterial fermentation.
Effective in concentrations of electrolytes up to approximately 50,000 ppm sodium chloride.

APPLICATION

This product is effective as a fluid loss reducing agent, protective colloid and stabilizing agent for low-solids, water-base emulsion mud. Milchem CMC is effective in the presence of salt contamination up to 50,000 ppm and is also effective in the presence of soluble calcium, making it particularly suitable for filtration control in the presence of cement contamination.

RECOMMENDED TREATMENT

High Viscosity Grade - A viscosity builder and fluid loss control agent in low solids muds when used in concentrations of from 0.1 to 1.0 ppb.

...continued

Medium Viscosity Grade - A fluid loss control agent and viscosifier in water-base muds when used in concentrations of from 0.25 to 2.0 ppb.

Technical Grade - A fluid loss control agent in sea-water muds when used in concentrations of from 0.5 to 2.0 ppb. In gyp, lime-treated, or fresh water muds, a concentration of 0.5 to 2.0 ppb is recommended.

PACKAGING

Milchem CMC is packaged in 50-pound multi-wall bags.

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Milchem®
Drilling Fluids Division

PRODUCT BULLETIN

SOLTEX

DESCRIPTION

A compound containing sodium asphalt sulfonate which is manufactured in the form of a black, free-flowing, flake material. Soltex has a specific gravity of 0.98 and a dry bulk density of 50 pounds per cubic foot. It is non-biodegradable and high-temperature resistant. The softening point is in excess of 500° F. Soltex is approximately 70 per cent water soluble. A part of the water insoluble fraction is oil soluble. Because of this solubility property in both oil and water, Soltex has excellent emulsifying characteristics.

APPLICATION

Stabilizes shale formations --- Reduces torque and drag --- Acts as a substitute for oil (particularly suitable for offshore operations where no oil-containing mud can be dumped overboard) --- Forms tight emulsions where oil is used --- Inhibits the dispersion of drill solids --- Aids in the control of high temperature filtration properties --- Produces a thin, strong wall cake --- Acts as a corrosion inhibitor at elevated temperatures --- Controls shear strength of packer muds.

Milchem®
Drilling Fluids

PRODUCT BULLETIN

LD-8™

DESCRIPTION LD-8 is a non-hydrocarbon base defoamer for both fresh water and salt water applications. It is non-oil containing and causes no oil slick or sheen when used on water locations. It is non-toxic to marine life or humans and is readily biodegradable.

APPLICATION LD-8 is a viscous free-flowing liquid which is added directly to the mud system. It should not be diluted with oil or water. LD-8 remains effective even after initial defoaming and continues to suppress foam generation over extended periods of time. Rigorous agitation appears to enhance the defoaming property of LD-8.

LD-8 appears to be particularly effective in controlling the foam of polymer fluids which are characterized by high yield point to plastic viscosity ratios. The high

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fluid phase viscosity imparted by the viscosifying polymer often can result in considerable body foam, which LD-8 is quite effective in removing.

RECOMMENDED TREATMENT The concentrate is added directly (without dilution) to the mud system as needed.

PACKAGING LD-8 is packaged in 5-gallon cans.

Milchem®

Drilling Fluids Division

PRODUCT BULLETIN

MILCHEM MD ™

DESCRIPTION

A drilling fluid detergent compounded for use in water-base drilling fluid systems.

APPLICATION

Milchem MD, a highly active detergent and wetting agent, reduces balling of shale cuttings, thereby increasing penetration rate; and lowers surface tension of the fluid phase, thereby promoting the settling of drill solids in the pits. This product is also useful as an emulsifier and aids in the reduction of torque and drag. Utilized primarily for upper-hole drilling, Milchem MD is specially compounded to be tolerant to the adverse effects of electrolytes allowing its use in all water-base muds.

RECOMMENDED TREATMENT

Normal recommended treatment is 0.02 to 0.04 gallons per barrel of mud.

PACKAGING

Milchem MD is packaged in 5-gallon cans and 12-gallon drums.

Milchem®

Drilling Fluids Division

PRODUCT BULLETIN

MIL-GARD™

MIL-GARD is an effective metallic, non-corrosive sulfide scavenger for the control and removal of soluble sulfides which become incorporated in aqueous muds from formation hydrogen sulfide gas. Mil-Gard is a free-flowing powder that can be added through the conventional mud hopper. It is slightly alkaline in water and exhibits excellent buffering action against acids.

When hydrogen sulfide gas is anticipated, it is recommended that the mud system be pretreated with 2.0 to 3.0 ppb of Mil-Gard. If the hydrogen sulfide intrusion is severe, additional Mil-Gard will be required to control the sulfides.

Mil-Gard is non-corrosive to steel and will not plate-out on tubular goods like that experienced with the commonly-used copper carbonate.

Mil-Gard is believed to exhibit a low order of toxicity. No special handling procedures are required.

Mil-Gard is packaged in 50-lb multi-wall bags.

COMPARISON OF SCAVENGING PROPERTIES OF MIL-GARD WITH COPPER CARBONATE IN MUD

Personnel involved in the drilling of oil and gas wells where hydrogen sulfide is encountered are well aware of the problems that arise from the gas intrusion into the drilling fluid. Besides being a hazard to the rig personnel, it is highly corrosive to oilfield tubular goods.

The general practice today is to use copper carbonate to remove or precipitate the sulfide in the mud. Copper carbonate is effective as a sulfide scavenger, but experience in the field has shown that this compound will cause severe bimetallic corrosion caused by the plating action of the ionic copper onto the steel.

This serious deficiency of the copper carbonate gave rise to the development of a product that would be as effective as copper carbonate as a scavenger but without the objectionable corrosive property of the copper compound. This product is Mil-Gard.

The following tests were conducted in the laboratory to compare the effectiveness of Mil-Gard with the commonly used copper carbonate in regard to sulfide removal. To illustrate this effectiveness, a laboratory Uni-Cal mud was prepared and the pH adjusted to 11.0 prior to the introduction of hydrogen sulfide gas. The hydrogen sulfide gas was dispersed into the mud by means of a fritted glass dispersion tube. The gas was added until the mud pH dropped to 8.5. The process was repeated to insure sufficient sulfide in the mud.

To one-barrel equivalents of the hydrogen sulfide-contaminated mud was added, respectively, 3 and 6 lb/bbl of Mil-Gard and basic copper carbonate. The muds were hot-rolled for 16 hours at 150°F, cooled, and the API filtrate measured. The filtrates were then analyzed for sulfide.[1] Table I shows that Mil-Gard is as effective as basic copper carbonate on a pound-for-pound basis in removing sulfides.

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[1] Standard Methods for the Examination of Water and Waste Water, American Public Health Association, New York, N.Y., 12 Edition, 1965, pp 427-428.

Table I

Scavenging Properties of Mil-Gard and Copper Carbonate in Removing Soluble Sulfides from a Uni-Cal Mud Containing Sulfide

Scavenger	Concentration ppb	Sulfide Content of Mud Filtrate, ppm
Base Mud	-	790
Mil-Gard	3	86
Mil-Gard	6	0
Copper Carbonate	3	52
Copper Carbonate	6	0

COMPARISON OF THE CORROSIVENESS OF COPPER CARBONATE WITH MIL-GARD

The major property difference between Mil-Gard and copper carbonate is that Mil-Gard is NON-CORROSIVE TO FERROUS METALS, whereas copper carbonate is highly corrosive. This fact has been substantiated by a series of laboratory tests involving both fatigue and dynamic corrosion tests. A brief description of the test techniques employed and the data obtained are given below for comparing the corrosiveness of copper carbonate to Mil-Gard.

Fatigue Corrosion

A base mud was prepared containing 15 ppb Milgel, 2.0 ppb CMC, 6.0 ppb Uni-Cal, and 1.0 ppb NaCl. The pH was adjusted to 9.0. All fatigue tests were made at 150°F with the Conoco Flex Tester. A stress of 3.16×10^4 psi was applied to each mild steel test specimen. The first test employed the untreated base mud. The second test included the base mud treated with 1.5 ppb of copper carbonate, and the third test was the base mud treated with 2.0 ppb Mil-Gard. No hydrogen sulfide was present in the base mud, as this test was designed to show only the effects of the scavenger on the fatigue life of the stressed specimens.

Table II lists the results of the fatigue corrosion tests. The base mud exhibited an average corrosion fatigue life of 2.30×10^6 cycles compared with a life of 0.823×10^6 cycles for the copper carbonate and 2.27×10^6 cycles for Mil-Gard. As shown by this test, the copper carbonate reduced the fatigue life of the specimens in the treated fluid by about two-thirds of the base mud level, whereas Mil-Gard showed no appreciable effect on the fatigue life of the stress specimens. The average number of hours to failure for the base mud was 51.9 compared with 18.5 hours for the copper carbonate-treated mud and 51.1 hours for the Mil-Gard-treated mud.

Table II

Corrosion Fatigue Life of Specimens in a Mud Treated with Copper Carbonate and Mil-Gard

Treatment	Specimen No.	Time to Failure (hrs)	Cycle to Failure
Base Mud (No Treatment)	1	45.7	2.03×10^6
	2	53.6	2.38×10^6
	3	56.4	2.51×10^6
		51.9 Average	2.30×10^6 Average
1.5 ppb $CuCO_3$	1	18.0	0.802×10^6
	2	20.5	0.912×10^6
	3	17.0	0.757×10^6
		18.5 Average	0.823×10^6 Average
2.0 ppb Mil-Gard	1	39.3	1.74×10^6
	2	56.0	2.48×10^6
	3	58.1	2.58×10^6
		51.1 Average	2.27×10^6 Average

Examination of the test specimens (See Figure 1) exposed to the base mud and the copper carbonate-treated mud revealed shallow pits under solids deposits. The specimens taken from the copper carbonate-treated mud revealed extensive copper plating on the surface with deep pits and fatigue cracks. Numerous transverse fatigue cracks were also located near the edges of the coupons, and the specimens were broken nearer to the neck, indicating a more corrosive environment. Specimens taken from the Mil-Gard-treated mud showed less evidence of surface attack than that coupon from the base mud.

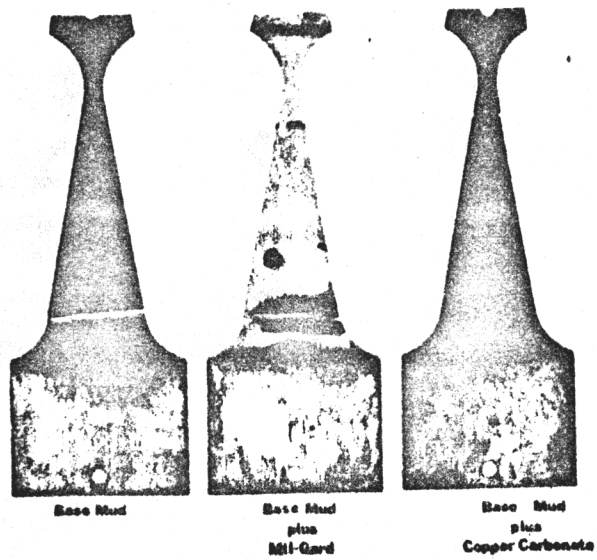

Figure 1 Corrosion Fatigue Specimens

Dynamic Corrosion Tests on N-80 Tubing

Dynamic corrosion tests were conducted in a laboratory-prepared 9.0 pH, 10 ppg Uni-Cal mud. N-80 test coupons were suspended in the mud in a dynamic corrosion cell, and the mud was agitated continuously at 150°F for 88 hours. In one test series the corrosion rate of the N-80 coupons was measured in the presence of Mil-Gard and copper carbonate but without sulfide present. The second series included the addition of sulfide as hydrogen sulfide gas. Table III shows the results of the tests.

Table III

Corrosion Rate of N-80 Tubing in a Uni-Cal Mud Treated With Mil-Gard and Copper Carbonate

A. Without Sulfide (2 ppb of Scavenger Added)

	Base Mud	Mil-Gard	$CuCO_3$
MPY Loss	7.4	2.3	12.7
MPY Loss*	6.3	3.8	16.3

B. With H_2S Added to Mud (4 ppb of Scavenger Added)

	Base Mud**	Mil-Gard	$CuCO_3$
MPY Loss	75.9	0.6	7.5

* Replicate Test

**Base Mud filtrate contained 285 ppm $S^=$ at end of test.

6.

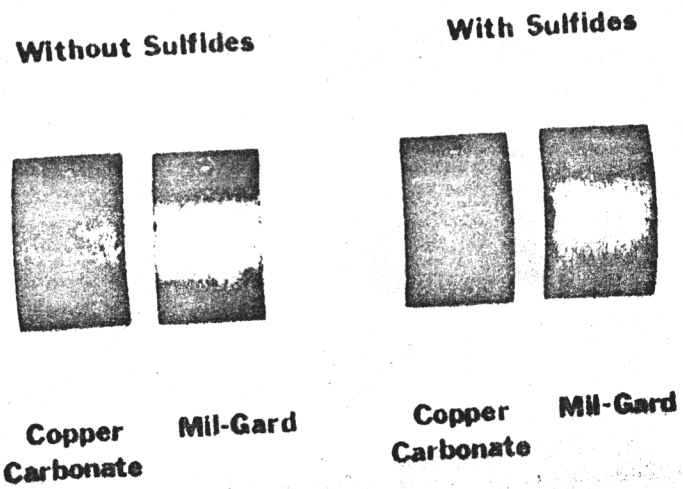

Figure 2 Effect of Sulfide Scavenger on Corrosion of N-80 Steel

Figure 2 shows the test coupons after the completion of the tests. Copper carbonate "plated out" on the N-80 coupons and exhibited a corrosion rate about twice that of the base mud without sulfide present. Mil-Gard shows a reduced corrosion rate, indicating corrosion protection properties.

In the presence of the sulfide-contaminated mud the copper carbonate-treated sample showed a reduced corrosion rate. This lower rate may be attributed to the lower concentration of ionic copper available from the cuprous and/or cupric sulfide precipitated by the copper carbonate. Again, Mil-Gard was significantly better, indicating a minimal corrosion rate of only 0.6 MPY.

NON-PLATING PROPERTY OF MIL-GARD

It is well known that copper salts will "plate out" onto steel to cause damaging and expensive bimetallic corrosion of steel. Mil-Gard will not plate out onto steel.

COMPATIBILITY WITH LUBRI-FILM

Three test solutions were prepared. Solution 1 contained 6.0 ppb Uni-Cal with pH adjusted to 9.0; solution 2 contained 6.0 ppb Uni-Cal and 4.0 ppb Lubri-Film with pH adjusted to 9.0; solution 3 was the same as solution 2 with the addition of 3.0 ppb Mil-Gard.

N-80 coupons were cleaned and placed on ceramic supports in stainless steel aging cells containing the above solutions. They were aged 24 hours at 300°F without external pressure applied to the cells. Hydrophobic films were observed on both coupons exposed to solutions 2 and 3. These tests were repeated for 72 hours at 150°F, and similar hydrophobic films were noted on solutions 2 and 3.

These tests indicate that Mil-Gard is compatible with Lubri-Film.

COMPATIBILITY OF MIL-GARD IN FIELD MUDS

Mil-Gard has been added to various field muds to determine the effects of the product on the rheological and filtration properties. Slight increases in the viscosity and gel properties have been observed to occur in some muds, but filtration properties were essentially unaffected.

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The above test information shows clearly that a superior sulfide scavenger has been created by Milchem Research to assist in the drilling of hydrogen sulfide-producing formations.