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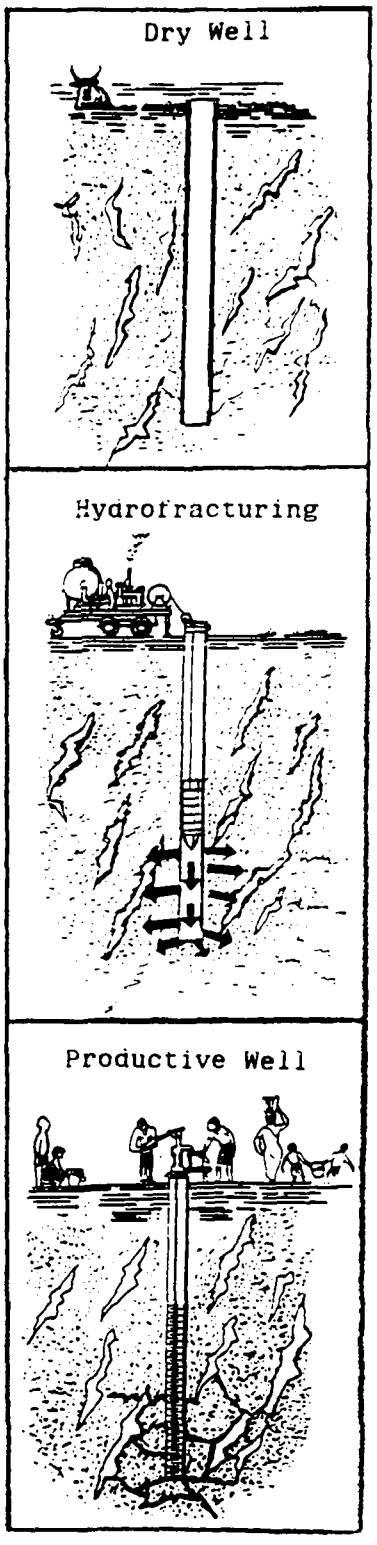
WATER and ENGINEERING

technical information bulletin no. 001

HYDRAULIC FRACTURING, HOW IT WORKS AND WHERE TO USE IT

Lots of waterwells are drilled through overburden and into bedrock. There are several reasons for this:

- In many cases the overburden is to shallow to reach the ground water you have to drill deeper, into the bedrock.
- In other cases the water in the overburden is not suitable for drinking: contaminated, smelly or miscoloured. Therefore a casing is set through the overburden, and a good bit (6 feet or more) into the bedrock, and possibly cemented to prevent water from the overburden to enter the well.
- These wells in the bedrock normally have a diameter of 4 1/2" or 6 1/2", and will give some 500 gallons per 24 hours, on the average.
- The water entering the well has of course originated at the surface somewhere in the area, passed the overburden and then been deposited in the innumerable small natural cracks in the bedrock. This process has cleaned the water of all bacteria and other contaminations. The amount of water flowing into the well is of course depending on the size and number of cracks in the rock. A well drilled into good solid rock will not give very much water, might even be completely dry even with lots of groundwater around.



- Hydrofracturing a "dry" well will open up natural cracks and even make new cracks in the rock and thereby increase the waterflow for the well many fold.

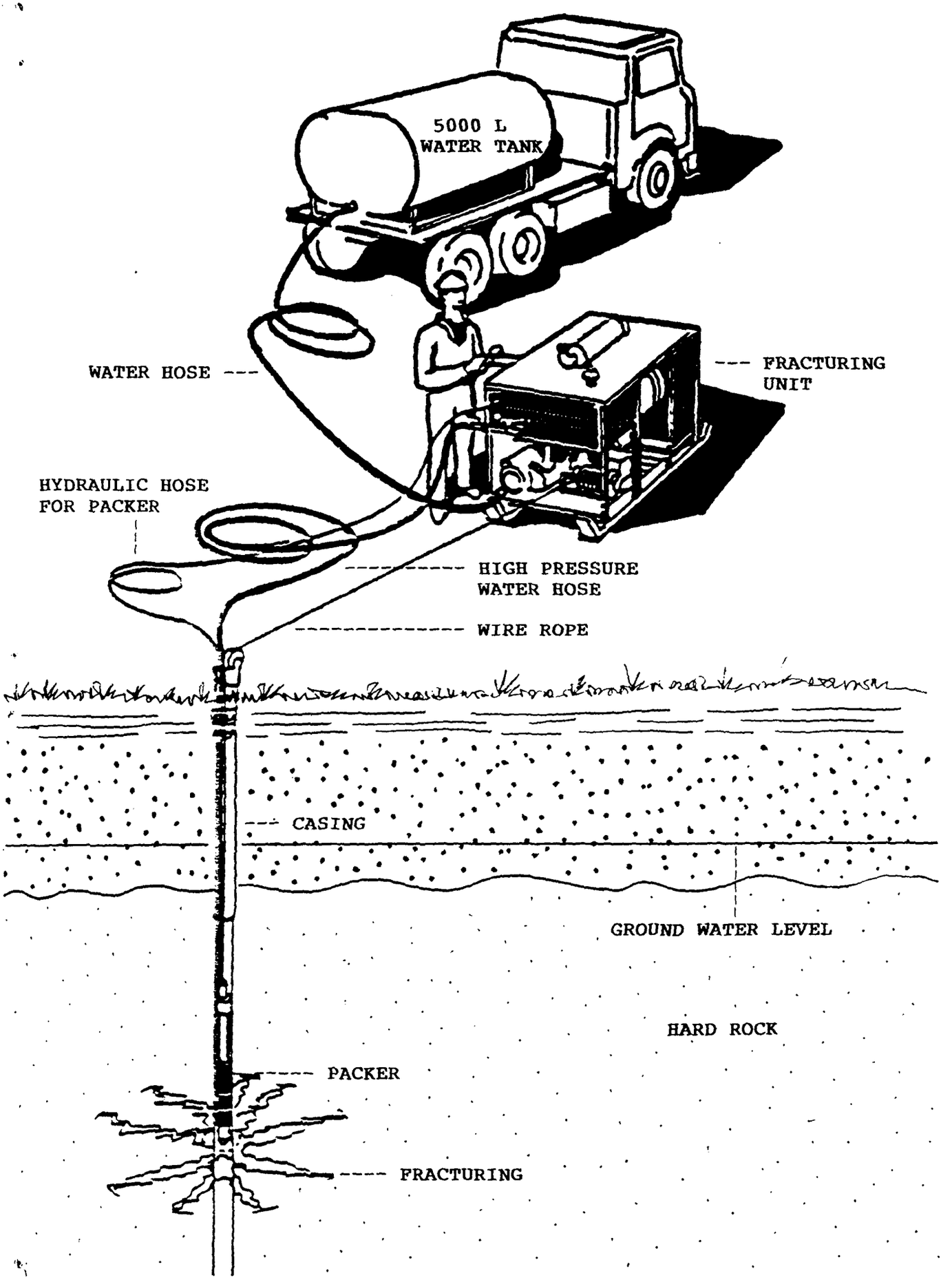
- Hydrofracturing will increase the cost of the well by a few percent (4 to 8), but will also increase the capacity of the well 5 to 10 times.

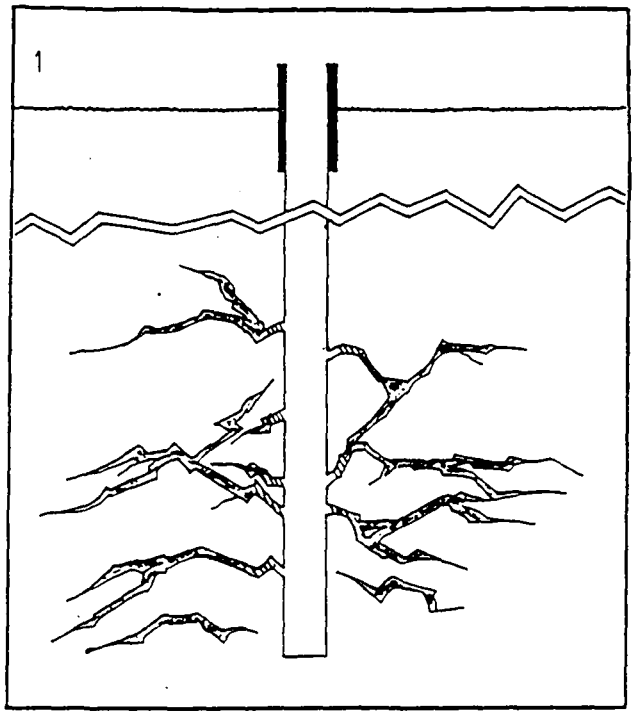
- Technically hydrofracturing is a quick and simple procedure with the right kind of equipment. The equipment consists of a high pressure water pump, a packer and a watertank.

- The packer is actually a rubber plug that can be lowered into the drillhole. Once the packer is at the correct level it is expanded by means of a built in hydraulic cylinder. This cylinder is connected to a small hydraulic pump on the surface by a hydraulic hose. When the hydraulic pump is started the packer expands in the drill hole, rubber seals are pressed against the hole wall with great force. The hydraulic oil used is biodegradable and non poisonous for safety reasons. Once the packer is set, the high pressure water pump is started and water is pumped through hose which is connected to a pipe going throuh the packer, and pressurizing the drill hole below the packer. A pressure gauge is connected to the pump, this gauge will show what is happening in the drill hole. The pressure will increase up to a certain point, maybe 60-70-80 Bar (900 to 1200 PSI), then something cracks (actually the rock) and the water pressure drops down to a few bars, just the pressure needed to force the water from the pump into the rock. Old cracks are opened up and cleaned of clay or deposits, and new cracks have appeared, ground water can flow into the well more or less unrestricted.

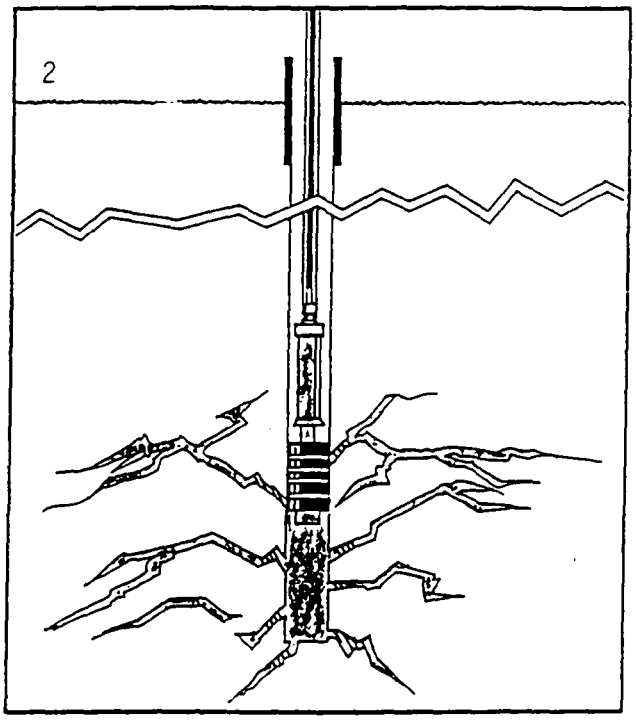
- Why does the rock crack at a certain pressure? Basically one has to increase the pressure in the hole until it lifts up the rock and overburden above the packer level. Assume that the packer is set at 50 meters, the pressure under 50 meters of water is 5 Bar, rock has 2.5 the specific weight of water, thus the rock pressure is 2.5 X 5 = 12.5 Bars. Cracks will start to open above this pressure. For efficient hydrofracturing of 4 1/2" and 6 1/2" wells the pump should have a capacity of 330 litres/minute at 115 Bars.

Hydrofracturing has shown to be successful in 9 out of 10 wells, in the 10th well even a good system of cracks around the well is not enough to lead the groundwater into the well, the formation as such has a low capacity, or even worse, the water table is below the depth of the well and hydrofracturing is then of no use.

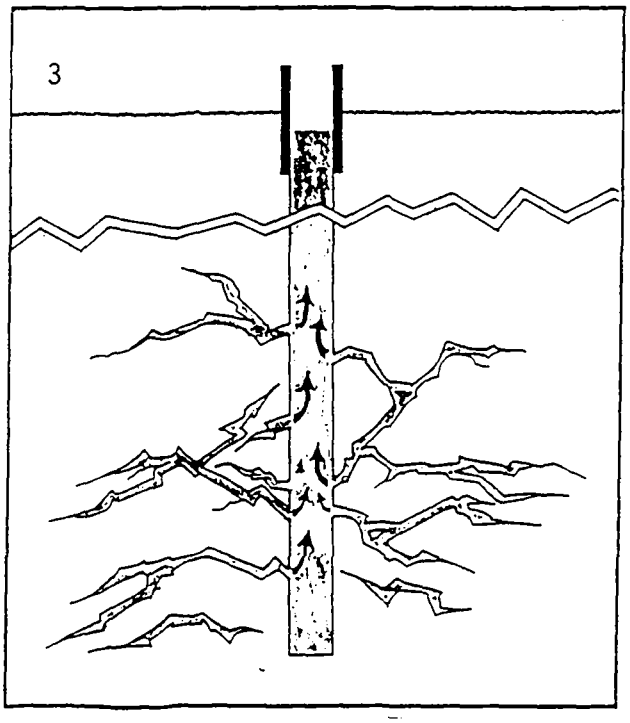

5000 L
WATER TANK
WATER HOSE ---
--- FRACTURING
UNIT
HYDRAULIC HOSE
FOR PACKER
---------- HIGH PRESSURE
WATER HOSE
---------- WIRE ROPE
--- CASING
GROUND WATER LEVEL
HARD ROCK
---- PACKER
---- FRACTURING



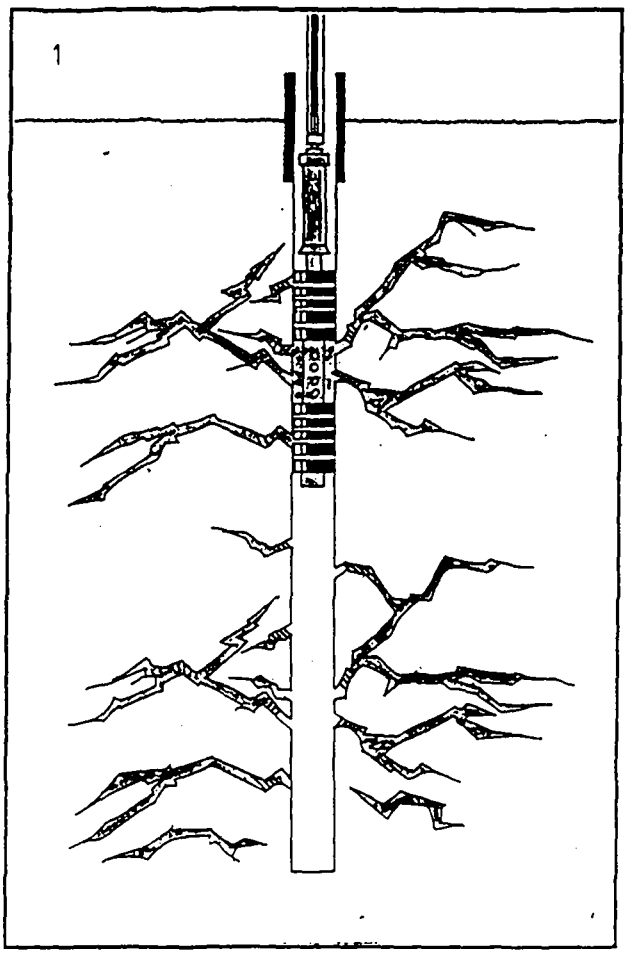
1. The well is obstructed by silt, sediment or deposits.



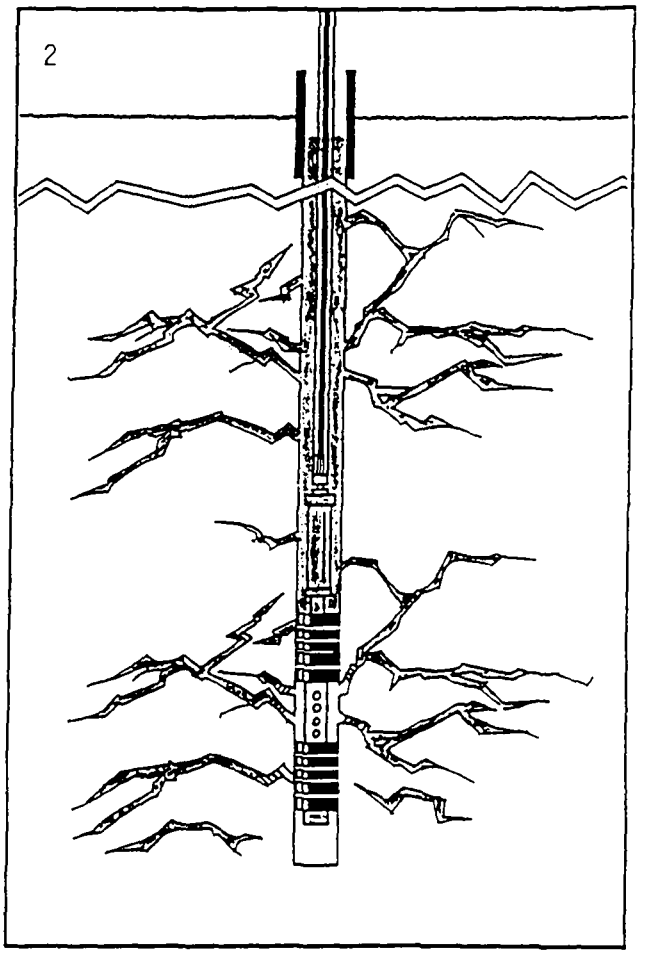
2. Hydrofracturing injects fresh water under high pressre.



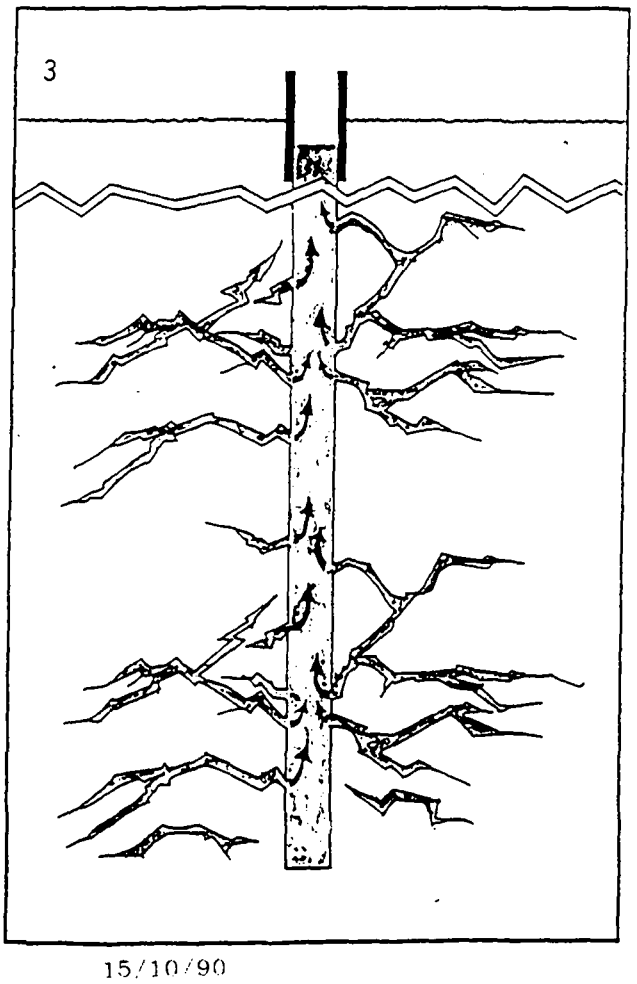
3. The obstructions are forced out of the water-proof fractrues. Water can flow freely.



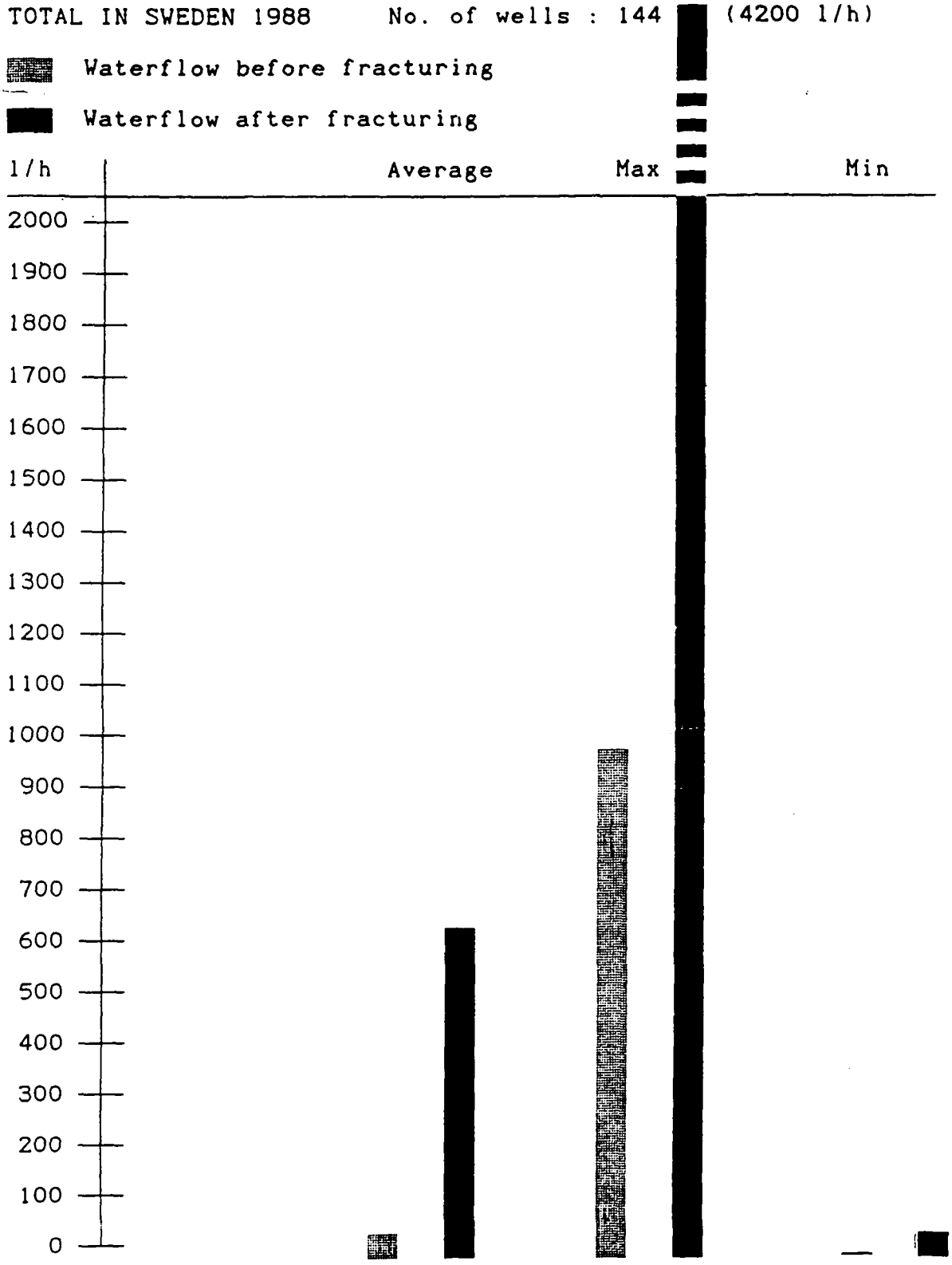
1. For maximum yield, zone-fracturing isolates specific zones within the formation.



2. By concentrating the injection to where it's needed most, zone-fracturing insures optimum yield.



3. Once a zone is free of obstructions, the process is repeated at multiple depths.


TOTAL IN SWEDEN 1988
No. of wells : 144
(4200 l/h)
Waterflow before fracturing
Waterflow after fracturing
l/h
Average
Max
Min
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

RESULTS FROM HYDROFRACTURING IN THE LUWERO TRIANGLE,

UGANDA, OCTOBER 1986

Bore Hole	Yield before fracturing 1/hour	Yield after fracturing 1/hour	
1	180	1,300	
2	540	620	
3	280	850	
4	1,100	1,500	too soft formations
5	50	1,050	
6	650	1,000	
7	1,000	2,000	
8	dry	450	
9	dry	850	
10	50	50	problems with packer
11	50	850	
12	50	1,000	not sufficient test pumping

Hydrofracturing Unit

Complete unit powered by preferably a 6 cylinder turbocharged Deutz diesel engine with continuous output of 109 Kw at 2,500 rpm. Equipped with electric start, batteries to be included, rpm and hour run meter to be mounted on side of engine.

Engnine should also be equipped with:
- High oil temperature indicator lamp and shut down.
- Low oil pressure indicator lamp and shut down.
- High cylinder temperature shut down.

Fuel tank to have capacity of 120 litres and equipped with lockable filling cap. High pressure paump to be connected to engine via hand operated twin disc clutch. High pressure pump to have adjustable working pressure of 0 - 150 bar and amximum flow capacity of 350 litre/minute. Operating winch with pulling capacity bare drum of 1000 kg including 120 m wire to be mounted. Unit to be mounted on sturdy skid frame ready for mounting on truck carrier. One tripod with sheaves with capacity of 120 m pipe and packer weight including safety margin to be included. Skid to have sufficient storage space for tripod. Complete unit must be protected against vandalism by complete housing of metal sheets and lockable doors.

Accessories for Hydrofracturing Unit

1 each high pressure hose, diameter 1". Lenght 50 ft. (115 m) for connection between High Pressure Pump and bore hole. Set of two, including couplings.

1 each suction hose. ID 1 1/2" (38 mm) for connection of primer pump to external reservoir. Length 394 ft (120 m).

33 each aluminium pipe, size 1 3/4" (45 mm). Length 10 ft (3.05 m), weight 16.4 lbs (7.43 kg) OD 1 11/16" (42.9 mm), wall 1/4" (6.2 mm).

1 each hydraulic pump, manually operated for inflating of packer. Manual design, max pressure 9840 psi (700 bar).

4 each hydraulic hose 1/4" (6.2 mm) set with fitings for connection of packer and pump. Length 100 ft (30 m).

1 each holding wrench for aluminium pipe, inlcuding jaws.

2 each pipe wrench for tightening and unscrewing of aluminium pipes.

40 each couplings for connecting of aluminium pipe and valve set.

40 each couplings aluminium-pipe and packer.

20 each single packer complete with rubbers for 6 1/2" (165 mm) bore, hydraulically expanded.

TOTAL COST FOR ABOVE ACCESSORIES USD 25,000.00.