4. Drilling with foam

Drilling with 'foam' combined with compressed air is used in different ways to help the drilling process. It involves using small-capacity pumps to inject a 'foam' mix at quite low flow rates into the compressed air supply line to make soap bubbles form in the borehole (Figure 4.1).

4.1 High velocity foam – air misting

When drilling consolidated rock with compressed air, clouds of dust can be blown out of the hole. Pumping a trickle of water into the airline will very effectively dampen the dust cloud, protecting both the health of operators and the equipment. Adding a soap solution (0.5 – 1.5% dilution) helps keep the hole walls clean and prevents small water-bearing fissures being clogged up and damp collars of drill cuttings forming above the drilling action. Typically, soap solutions used are biodegradable surfactants: they can be bought as specialist drilling additives or, conveniently and cheaply, as plain quality liquid dish-washing detergents or cold-water-mix laundry washing powder. Using foam, it is possible to drill successfully at lower up-hole air velocities because the foam keeps the hole cleaner and the bubbles help lift material clear at lower speeds.

4.2 Low velocity foam – stable foam column

By steadily injecting a mix of polymer drill mud (35-40 Marsh funnel seconds) and drill foam (0.5–1.5% dilution) into a flow-controlled air supply, it is possible to create a slow-rising column of stable foam, which lifts material out of the hole. It does not erode the formation and uses very little air, therefore allowing large diameter holes to be drilled in soft formations with small compressors. The effect to be created in the hole is a continuous mixed column of rising foam bubbles – similar in consistency to that of aerosol shaving foam. The foam will 'mushroom' in waves out of the top of the hole, carrying the drilling debris from the drill bit. If too much air is mixed with too little foam flow, little foam will erupt and the column will be broken by pockets of air. Good stable foam, if scooped between a pair of hands will lay quite thick and prevent the hand palms from touching easily. It will form a mass of soap bubbles with a definite body to it. The foam texture will change after water is laying in the hole – the bubble structure often gets larger with more dilution.

It is an impressive technique to apply to constructing a hole in the ground using very little compressed air and a small volume of water. It should be seen to be believed and time should be allowed for inexperienced drill crews to get confident in its application.

4.3 Poor hole stability and a very messy operation

Unfortunately for the water-well driller, this 'slow foam' does not offer any 'hydrostatic' support to prevent holes in soft formation from collapsing inwards – particularly because the most common reason for collapse is the presence of ground water. Such formations are better drilled with circulation

Figure 4.1 Drilling with stable foam

fluid, when a hydrostatic head will prevent hole collapse.

It is hard, but not totally impossible, to collect a good set of representative samples as the borehole debris is carried and hidden in an expanding blanket of foam around the rig site. If left unchecked it will literally blanket the entire drill site, hiding sound footing and any tooling and hoses left on the ground. A certain amount can be done to channel the foam blanket away from the rig by creating plywood or similar flow channels. Sunlight and time effectively breaks down the bubbles. In high wind the foam can blow around and spread its mess a considerable distance – after the foam has broken an even blanket of debris will be left as testament to the foam's ability to carry and hold material. It is not a method for an environmentally challenged site.

4.4 Non-return valve sub adapter

When drilling with 'slow foam' under the water rest level of a borehole, where water is lying it is essential to fit a 'non-return valve sub adaptor' above the drill bit. This will allow the foam mixture through to the drill bit but will not allow flow back up the drill pipe. This valve will prevent the resting water and debris at the base of the borehole to flood back inside the drill bit and drill pipe when the air and foam mix is stopped – for instance to add on another drill pipe. If debris does flow back into the drill pipe it is very likely to block the downward flow in the restricted bore of the drill pipe once air and foam mix is started again.

4.5 Where can it be used?

It is a very useful method to drill a larger diameter than the air compressor capacity could drill directly, for instance to set and seal surface casing. It can also be used to drill a complete well in a soft rock formation that is stable from collapse because little fluid pressure is exerted on the borehole sides and very little invasion of the water-bearing permeable layer will occur. It might be sensible to have piloted a small-diameter hole to depth with air or water to collect samples and log the formation, and then use foam drilling to ream out the final hole diameter.

4.6 Well dippers

Well dippers fitted with sensitivity controls can be set to detect the rest-level of foam in a hole and alternatively set to detect the water column that might be underlying the foam layer. Without this sensitivity control, beware that any water-level readings might be misleading if the dipper is signalling the presence of a foam column rather than a water rest level.

4.7 Foam pump types

Many types of pump are suitable for use for foam injection purposes. The basic requirement is the ability to pump a slightly viscous, but clean, fluid up to the maximum pressure of the air compressor (nominally above 6 bar [100 psi]) at relatively low delivery volumes (1–20 litres/minute [.25 - 4 gallons/

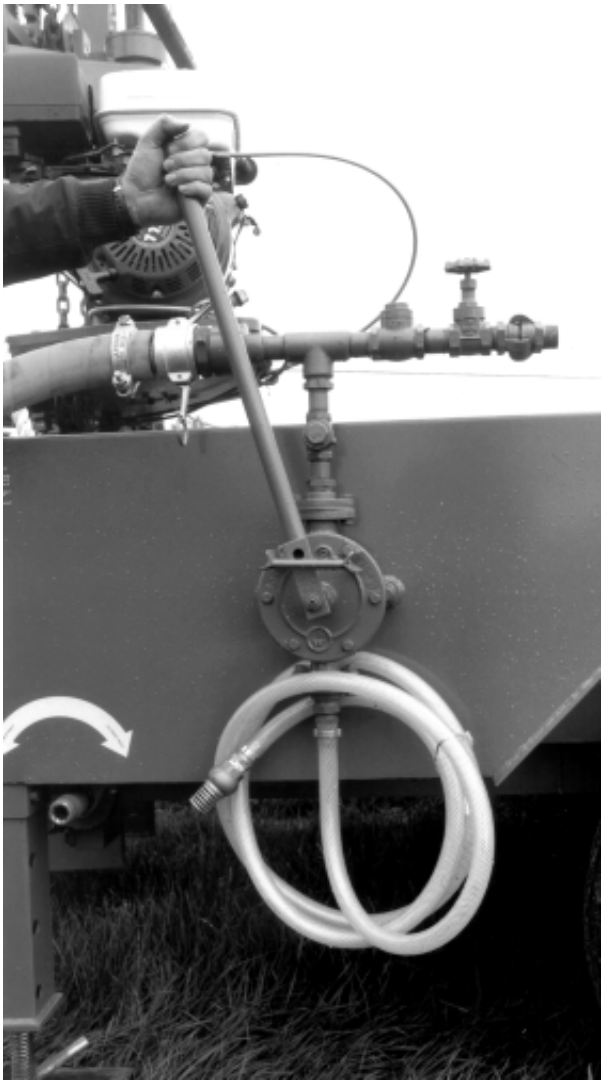

Figure 4.2 Semi rotary hand pump

minute]). This will meet most foam drilling requirements. The following types of pump can be used:

4.7.1 Hand Pump

Semi rotary or piston 'pressure testing' pump; (figure 4.2)

4.7.2 Barrel Type Pump

Air- or electric-powered typical product transfer pumps designed to work from standard 200-litre (45 gallon) drum;

4.7.3 Piston Pumps

Duplex or triplex high-pressure pumps – typically 'water-pressure wash' duties. These are readily available as electric-, petrol-, or diesel-powered.

The most significant attribute of any foam pump is being able to control the injection flow rate to just the minimum required – over-injecting does not often cause many problems other than wasting water and making more mess on the surface. In remote locations, where water is being carried long distances, it helps to conserve its use to the bare essentials.

4.8 Foam inlet manifold

A simple pipe manifold (figure 4.3) is required to allow injection of foam – standard fittings as found in most plumbers can be used. Both the foam pump and the compressor require protection from being back-filled with each other's medium by fitting non-return valves. For low-velocity foam a suitable gate valve fitted to the air supply helps regulate the air-flow to give the correct air/foam mix.

4.9 Mixing method

In both foam drilling methods a good mixing method is to use two, or possibly even three, 200-litre (45-gallon) open-topped barrels. In each drum mix the required foam formula, first mixing the polymer (only for slow foam) arriving at a convenient volumetric addition for the required viscosity, 35–40 Marsh funnel seconds (i.e. – 1 litre jug of polymer powder = 40 sec mix in 200 litres of water). Allow time for this mixture to yield viscosity. Add the foam .5 to no more than 1.5% dilution i.e. 1-3 litres of liquid soap or drill foam to a 200-litre barrel at the last minute, using just a few stirs with a clean spade or shovel to mix. Use water as clean as possible to mix to prevent fines and dirt from damaging or

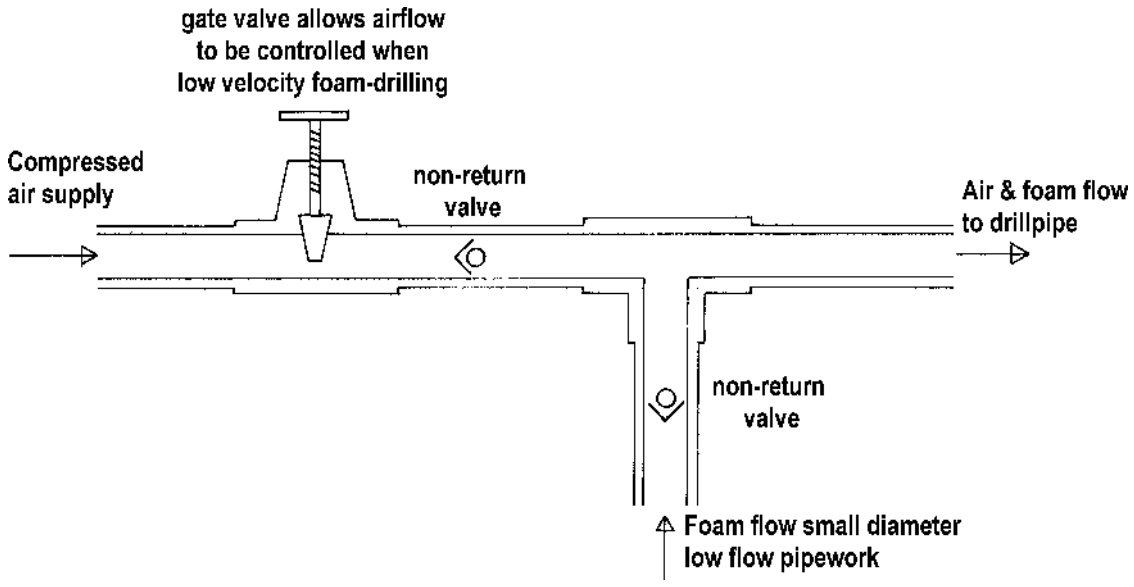

Figure 4.3 Typical foam injection manifold

blocking suction-line filters of the small parts and passages of the foam pump.

4.10 Adequate foam supply

Use the first barrel until empty and then switch the foam pump suction to the second barrel. While using this barrel, re-mix the first barrel. In this way, it will be possible to have a continuous foam supply available to the drilling operation. High foam consumption might dictate introducing a third barrel into the system to ensure that a mixed barrel of fully "yielded" polymer is always available.