WHY CABLE PERCUSSION?

Or, perhaps, why not rotary drilling in an African Rural Water context.

Rotary drilling can appear seductively fast in the right conditions. If you see a simple rig – perhaps only partly mechanised - drill 40 metres in 2 hours, it is difficult not to be impressed. But, the 40 metres was only a pilot hole, in ideal conditions; at least one more pass – more likely two - at a larger size would be needed before a casing could be installed. Only after the hole has been cased & pumped out, will it be possible to tell if there is water in the hole, or if it is dry. Not to mention the boulders that rotary drilling may find impossible.

If it is dry, the water is insufficient, or unsuitable for some other reason, the casing, screen and any other materials, and all the labour, will have been wasted.

If the same hole had been made by cable percussion methods, it would have been known if the water was drinkable, and was of sufficient quantity before any materials had been installed. If the water was found to be insufficient at that depth, the option of drilling deeper is available – unlike a rotary drilled hole that has been cased.

Cable percussion performs the excavation process in the dry, without use of mud or other chemicals. The hole is open and empty until water is struck. At that point, the volume and quality can be tested and even tasted. No materials have been wasted, and the exact sequence of strata can be laid out for examination with virtually undisturbed samples.

Then there is the cost. Drilling by cable percussion may seem to be slower, but the equipment required to form a **hole in any material** at a comparable size is from about only a quarter of that required by rotary methods at the same size. We are not talking about the cost of equipment to drill in soft sands – there are simple rotary systems, which do that very well and cheaply. But these do not deal with hard crystalline rock stones and boulders. They are defeated by the variable geology of African Basement Complex. That type of strata needs an ability to break boulders, which is not offered by rotary machines without the addition of down-the-hole hammers and the compressors to power them.

Cable percussion methods will break or pulverise hard rocks without additional pumps, compressors or hammers. The result can be bailed using standard tools. The process is not as fast as using a down-the-hole hammer, but it is very reliable and does not need a 100-hp compressor in addition to the rig.

In the developed world, speed is often seen as a virtue in itself. The perception is that labour is expensive, but capital goods are cheap. It is seen as better to spend money on a complicated rig that drills fast. In small business and African terms this is not the case. It is better to take a little longer to drill a hole than to employ expensive equipment that few people can understand & operate, even fewer can repair or maintain, and for which spares may take weeks to arrive.

Rotary drilling requires at least two engines to be running – perhaps more – at the same time, for the essential functions to operate:

1. Rotation is required – needing one power source
2. Flush is supplied by an engine driven pump or a compressor – perhaps 2 or even three mud pumps may be needed to supply suitable volume at adequate pressure
3. A foam injector may also be needed – another engine
4. In hard material a compressor, or compressors – and all the special tools – will be needed; with very thirsty engines

The Forager-55 cable percussion rig shown here drilling in UK was being powered by a 7½ hp diesel engine. Yet has drilled, & driven 20 metres (65.6 ft.) of 6-inch flush jointed temporary steel casing through a boulder clay with large flints, on into deposits of a glacier out-wash, weathered chalk with flints and finally into unweathered hard chalk. This would have been impossible with any rotary rig of remotely similar power and cost. On completion of the well, the casing was hauled out using only the power of it's own winch. The site is clean, the material having been taken away by hand barrow.

Some of these engines will be diesel and others petrol (gasoline). They all need both fuel and oil of a suitable type. These have to be obtained, stored and used safely. In Africa, petrol (gas) can often be difficult to obtain – diesel less so. All these engines and driven machines require maintenance, adjustment or up-keep. Rotary machines, which are not hydraulic will have a clutch, which is vulnerable and will require copious spares. Hydraulic rotary machines require replacement oil, filters and sophisticated 'understanding'.

With a cable tool rig, there is only one diesel engine and that is all. There are no centrifugal clutches, hydraulics, special oils or filters. The winch and engine are entirely mechanical and can be easily understood by most people.

Given the discussion about speed above, how slow is 'slow' drilling. If a cable tool rig can complete a well in a day, which previously took four weeks by hand digging, is that not fast? If the set-up of a cable tool rig can be completed and the first few metres of a 15 metre well drilled at full size while the mud pits are being dug for a rotary set-up – many would say that is fast. If when rotary drilling by mud flush several passes are needed to get to the size suitable for the installation of casing, and at that stage

Last revised: May 2009

it is still not known if water has been found – that is not really very fast.

When cable percussion drilling, it is obvious immediately both when water has been found, but also how much. The yield can be measured by bailing, samples taken, tested and even tasted. This is not possible with mud flush drilling because the mud masks everything. With a hole full of mud, there is no way to test either that you have found water, how much, or the quality. In order to do these things the hole must be cased and the mud pumped out. With cable tool these things are immediate because there is no mud, mud-pits, chemicals or disposal problem. Mud flush drilling requires a minimum volume of water equal to 3 times the eventual hole volume. Mud chemicals have to be purchased, delivered and stored in the dry until needed. If water is required for cable tool drilling it never exceeds the hole volume at the time, and no mud chemicals are required. Often the water required is small enough to be delivered by head pan, and used a cup-full at a time.

In geology that has thin yielding horizons, where the water is under very little pressure, it possible that mud used as the flushing medium may also destroy the aquifer being drilled. The mud, under pressure of a full borehole, is forced into the yielding layer to such an extent that it is mudded off – completely sealed. So that when the mud is removed, no water can flow into the well because of the sealing effect of the mud used to make the hole. This problem is helped if degradable mud is used, but this does not prevent the mud carrying natural clays and silts into the aquifer. There is almost no pressure in a weak thin aquifer to push the mud or natural clays out and to clear the way for water to flow into the well. Certainly there will be nothing like the pressure that was available to force the mud into the aquifer – that was the full height of the hole. The opposing pressure head will have been a few inches only.

SUMMARY

Cable tool drilling is often said to be slower – but is not that slow overall, and in many cases it is a quicker way of making shallow wells.

Cable tool uses less equipment at about ¼ to 1/3rd the cost of a rotary drilling set-up of similar capability.

Cable tool drilling has very low inputs. Some fuel, some labour, some water – that is all. No mud, mud pits, extra pumps, down-hole hammers or compressors, different fuels or storage & logistics problems.

Tools are cheap for cable tool drilling. There is the cable and tools to hang on the end of it; and everything, except the wire, can be made by a reasonable welder using scrap steel.

There is less chance of getting the tools stuck because they spend so much time out of the hole, and can be pulled up in a moment – unlike rotary drill tubes.

Cable tool drilling can deal with boulders and large stones that will defeat a normal rotary rig; it can even drill solid rock – all without additional equipment.

Cable tool drilling allows the hole to be cased at the same time as it is advanced, and the water can be tested for quantity and quality without loss of materials.

FURTHER NOTES ABOUT THE PICTURED RIG:

The small diesel engine on this rig uses about 5 litres of diesel fuel per day – just over 1.3 US gallons. The mixed conditions found at this site are typical of UK drilling, which is why the 'shell & auger' method of cable percussion drilling method is so popular - it will drill anything.

A variety of drilling tools was used to tackle the varied strata, including temporary casing. A bailer with a leather clack was used, a clay cutter, a stubber, sliding hammer and a cross bit to break flints and boulders. The maximum weight of tools & sinker was about 160 Kg even when driving casing. A high window clay cutter was also used with a retaining device to hold the more difficult material.

Hauling out the 800 kg of temporary steel casing required the use of a 3-part tackle (3 falls of wire and two snatch blocks) and the leg braces were all in place during the process. A three-part tackle on this particular machine generates about 3750 Kg of hoisting power (say, 8250 lbs.). A 5-part tackle has been used with the same machine, and 7 falls of wire are possible, multiplying the winch hoisting capacity by 7.

NOTE ABOUT MUD PITS

In order to drill using rotary mud flush, it is generally recognised that the volume of mud pits should be about equal to 3 times the eventual borehole volume. So for a hole intended to be 6 inches diameter, and 100 feet deep, mud pit volume should be about 59 cubic feet. Since this is greater than the volume of the first metre of a hand dug well 4½ feet diameter, it would be expected that mud pit excavation might take a whole day's work in typical African conditions. Then sufficient water would need to be brought to fill this volume – about 3100 lbs., 1400 litres, or 1.4 tons of water. Also, it should be remembered that mud pits do not happen by themselves, they need supervising, and to be in the right place. Along with the water, the mud powder must be delivered in good condition and ready to make lump-free mud.

During the same period of mud pit construction, by a team of perhaps 6-8 men, a cable percussion drilling machine could reasonably be expected to drill a 6-inch full diameter hole from 15 to 20 metres deep – 50 to 65 feet in the first day. The hole would be completed and tested before the end of day 2. The end of day 2 on the mud flush site would probably not see water tested or sampled, or any casing installed.

Which then, is the quickest method of drilling?

The cable percussion method will have required very little water, no mud, 10 litres of diesel fuel, and the labour of 2 men. The equipment was cheaper, and the consumables a fraction of that needed for mud flush drilling.

Which then, is the cheapest method of drilling?