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AN IMPROVED DOWNHOLE SAMFLERFOR GEOTHERMAL WELLS

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ABSTRACT

A new downhole sampler has been constructed by Ministry of Works and Development, Wairakei to enable up to eight, two litre samples to be collected daily during tracer tests. The sampler features a positive action trigger mechanism to reduce the risk of accidental sampling and a two litre sample capacity to reduce sampling times where large samples are required. A mechanical valve to replace the existing glass break off tube is under development.

INTRODUCTION

In the past, Ministry of Works and Development have used a MKI "Klyen Sub-Surface Sampler" to obtain downhole samples. This sampler uses an inertia mechanism to trigger the sampling by smashing a glass break off tube which allows the sample vessel to fill. Obtaining a sample at a specific depth requires that the sampler is lowered carefully to prevent accidental triggering. If accidental sampling occurs through lowering too fast or the sampler hanging up briefly then free falling, the operator may be completely unaware that the sample obtained is not the desired one.

The accidental triggering problem is aggravated when sampling highly deviated wells (e.g. KA29-max. drift angle 38°, NG18 maximum drift angle 31°). Lowering the sampler down an inclined slotted liner makes accidental triggering more likely. Experience has also shown that the inertia trigger is extremely difficult to operate in deviated wells.

The present Klyen sampler obtains a sample of between 450 and 700 cm^3 depending on the pressure and temperature condition at the sampling depth. This sample size is sufficient for most chemical analysis purposes. Radioactive tracer tests at Wairakei and Kawerau have required two litre samples for analysis. During the Wairakei tracer tests in July 1983 a two litre sample from WK218 took a full day to obtain as seven runs with the Klyen sampler were required.

To reduce the problems of accidental triggering and the sampling time when large samples are required, the improved sampler has a positive action trigger mechanism instead of an inertia trigger and a two litre sample capacity. The weight and dimensions of these two components are such that the sampler can be used with the present downhole instrument recovery tubes (ID = $2^3/_4$") and the existing wirelines (Breaking strain = 400 kg).

With the Klyen sampler presently in use it is necessary to replace the glass break off tube and check the sealing O-rings after each run. As the sampler is normally run without gauze filters to maximise sample recovery, the non return valve must also be stripped to ensure that no glass fragments are impeding its operation. These preparations are time consuming and could be eliminated if the break off tube were replaced with a mechanical valve.

To simplify preparation of the sampler a mechanical valve to replace the glass break off tube is now being developed.

TRIGGER MECHANISM

A positive action trigger mechanism allows the operator to "feel" the trigger mechanism operate or in the absence of feeling it operate, know that accidental sampling has occurred.

Two opposing double hinged arms are used. Although designed to trigger on the first casing or liner joint encountered as the sampler is slowly raised up the hole, practical tests have shown that the arm to casing friction is sufficient to trigger the sampler at any level. A shear mechanism in the arms prevents the sampler becoming irretrievably stuck if for example the $6^5/_8$" arms are accidentally run into 44" casing or liner.

To date interchangeable sampler heads have been constructed for 4½", $6^5/_8$" and $7^5/_8$" casing/liner.

SAMPLE BOTTLE

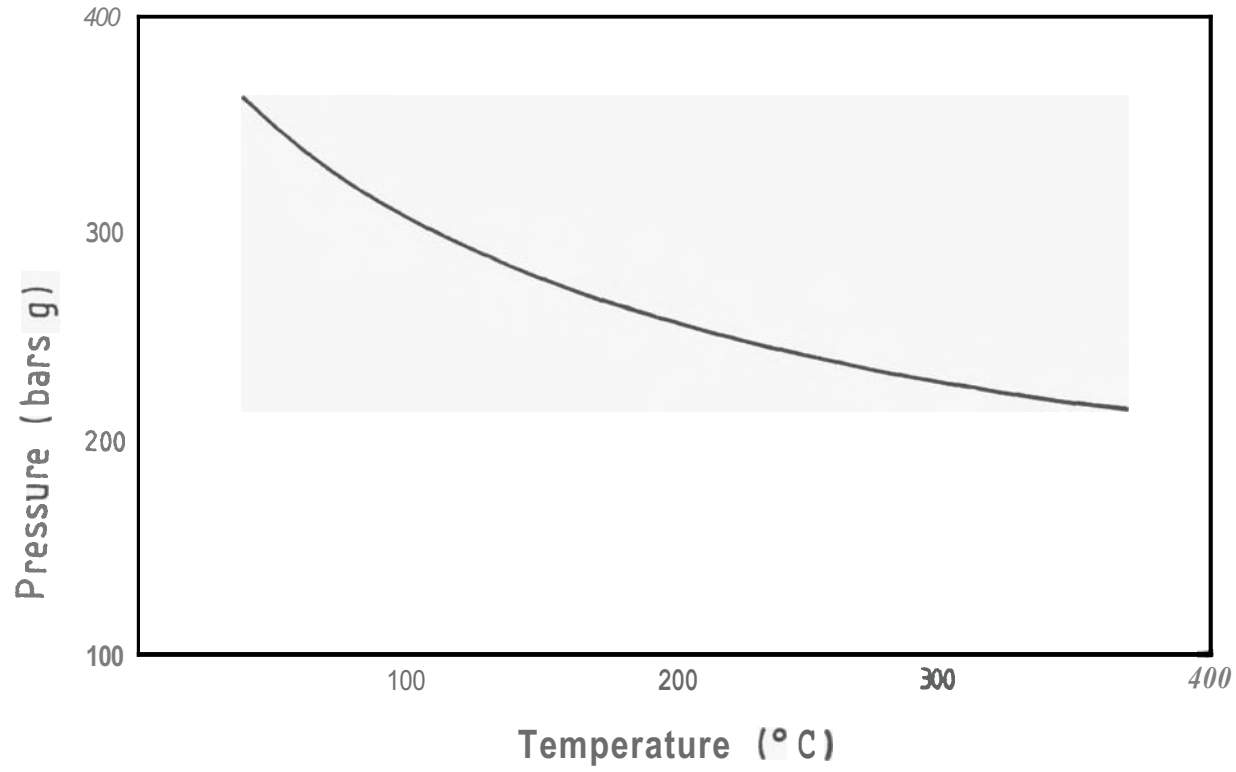
For general use the likely maximum operating conditions were assessed as up to 3000m depth and up to 350°C.

Two failure modes were identified for the sample bottle. These were explosive due to excessive internal pressure and implosive due to excessive external pressure. Given the material properties of the bottle, the failure pressure to explode the bottle can be calculated and the operational limits obtained using standard pipe codes. The failure pressure to implode the bottle however cannot be calculated and so samples were pressure tested to see if implosion was the critical failure mode and if so, at what pressure it occurred.

Two pipe sections were tested. These were:-

(a) 1¼" N.B. Schedule 5s Type 316 Stainless Steel Tube to Standard ASTM 312,

(b) 2" N.B. Schedule 40 Type 316 Stainless



'Figure 1: Maximum Operating Pressures for 2" N.B. Schedule 40 Type 316 Stainless Steel Sample Vessel.

200mm long samples of each were tested in a hydraulic pressure testing device. The 1½" N.B. tube failed by exploding at 350 b.g. The 2" N.B. tube was subjected to an internal pressure of 550 b.g. which caused it to swell but not rupture. The sample was then subjected to external pressure and imploded at 450 b.g. It was decided to construct the sample bottle from the 2" N.B. tube. The measured failure pressure was derated to allow for the sample bottle length, the operating temperatures and to provide a safety factor. The resulting graph of maximum operating pressure for various temperatures is shown on figure 1.

At some later date another sample bottle will be constructed to increase the maximum operating pressure at high temperatures.

VALVE ASSEMBLY

A mechanical valve is currently being developed to replace the glass break off tube. This will enable the elastomer O-rings to be dispensed with and hence allow fluid samples in excess of 300°C to be obtained. It will also simplify preparation of the sampler and improve reliability.

The new sampler head and bottle have been in use since August 1984 using a glass break off tube as an interim measure until the mechanical valve assembly is operational. The trigger mechanism configuration in the sampler head is such that a straight break off tube is used. This lends itself more readily to local manufacture, is considerably cheaper and is always correctly aligned to ensure break off.

CONCLUSION

The development of the new sampler head and bottle has enabled a more extensive sampling programme to be incorporated in the Kawerau tracer test programme than would have been otherwise possible. The sampler provides a sample in excess of 2 litres and enables the operator to be sure that it was obtained from the desired depth. Development work is currently being carried out to replace the glass break off tube with a mechanical valve. This will speed up and simplify preparation of the sampler.

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