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Acoustic Properties of Clathrate Hydrates and Hydrate-Saturated Porons Rocks

-A Progress Report

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Abstract

Preliminary experiments have been carried out to prepare samples of propane hydrate of sufficient dimensions to determine the elastic wave velocities. Previous measurements reported in the literature were made without composition information and are therefore of little use in attempting to quantify gas contents of natural hydrate horizons.

Résumé

Des essais préliminaires ont été accomplis en fait de préparer des échantillons d'hydrate de propane de dimensions suffisante pour déterminer la vélocité des ondes élastiques. Des données préalables rapportées littérairement ont été fait sans information composer et sont donc de peu d'utilité en tentant de quantifié la teneur en gaz des horizons d'hydrates naturels.

Acoustic Properties of Clathrate Hydrates and Hydrate-Saturated Porous Rocks

A Progress Report

by

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Introduction:

The experimental work done to date has essentially been involved with the preparation of a propane gas hydrate specimen whose dimensions are large enough to permit measurements of elastic wave velocities through it. This report includes a description of the pressure cell manufactured for this purpose, a schematic diagram of the apparatus used, results of the tests made and the work currently in progress.

Pressure cell:

A vertical section of the pressure cell is shown in Figure 1. The cell is 106 mm in length and 50 mm in diameter. It consists of brass plates at top and bottom enclosing a plexiglass cylinder. The latter can be replaced by a brass cylinder, if desired. A stirrer (Figure 2), very similar in design to one used by Stoll and Bryan (1979), is included as shown. The arrangement for the recovery of the hydrate specimen is shown in the bottom half of the figure. It consists of a teflon insert with a spiral groove behind it. Circulation of pressurized gas through the grooves will squeeze the hydrate specimen uniformly over its cylindrical surface thereby separating it from the wall of the pressure cell. The specimen can then be recovered for velocity measurements by removing the top plate.

Schematic diagram of the apparatus:

Figure 3 shows the complete setup presently in operation. The stop cock valve positions during the different steps in the preparation of the hydrate are as follows.

		1	2	3	4	5
(1) Evacuation of the cell.		C	O	C	C	C
(2) Introduction of water.	O - open	C	C	O	O	C
(3) Introduction of propane.	C - closed	O	C	O	C	C
(4) Recovery of hydrate.		C	C	O	C	O

Choice of gas hydrate:

It was decided to concentrate initially on the preparation of propane hydrate for the following reason. Propane hydrate is stable at atmospheric pressure provided its temperature is approximately -15°C. This fact is utilized in the recovery of the hydrate from the pressure cell -- a procedure which, as outlined above, will expose the hydrate to the atmospheric pressure when the top plate of the cell is removed.

Test results:

1. In the first attempt, the following procedure was adopted.

(a) The pressure cell was evacuated for two hours.

(b) The cell was then filled to about three-quarters its volume with distilled water at room temperature (approximately 25°C).

(c) Propane gas was then introduced at 0.4 MPa (60 psig).

(d) The mixture was stirred by hand for ten minutes and left overnight at ~1°C for about fifteen hours.

(e) Some hydrate flakes were observed at the base of the stirrer-compacting platen. The mixture had acquired a slight jellylike (cloudy) appearance.

(f) This set up was left undisturbed for about nine days when no further changes were observed in the cell. At the end of this period, the flakes beneath the base of the stirrer had acquired a somewhat cylindrical shape, and was roughly 15 mm in thickness. The rest of the mixture maintained a cloudy appearance.

(g) On release of pressure, most of the hydrate decomposed within 15-20 seconds.

2. In the second attempt, only one change was made to the above procedure. This time the cell was quarter filled with distilled water at $\sim 1^{o}C$. Hydrate formation began within 15 mintues. As before, flakes formed at the base of the stirrer. However, the quantity formed was much less, and remained so for a period of two weeks; after which the pressure was released and the hydrate decomposed.

The main conclusion from these tests is that while hydrate formation can occur using the present arrangement, some modification is necessary to enable the preparation of a quantity large enough for velocity studies.

Work in progress:

To achieve the above aim, it is intended to follow a procedure suggested by Stoll and Bryan (1979), wherein liquid propane is formed in the cell. They found that vigorous stirring of the propane gas, liquid propane and water was a very efficient way of preparing a large quantity of hydrate.

The main modification in the present set up necessary to form liquid propane in the pressure cell involves the pressurization of propane vapor over and above its vapor pressure (at a given temperature) in the gas tank. The pressure intensifiers needed to do this are available in the laboratory here. The above is required since the mere reduction of the temperature of propane vapor only lowers its vapor pressure without liquefying it.

Besides the preparation of hydrates and the velocity studies, it is also intended to determine the hydrate composition.

Reference

Stoll, R.D. and Bryan, G.M., 1979. Physical properties of sediments containing gas hydrates. Journal of Geophysical Research, vol. 84, No. B4, pp. 1629-1634.

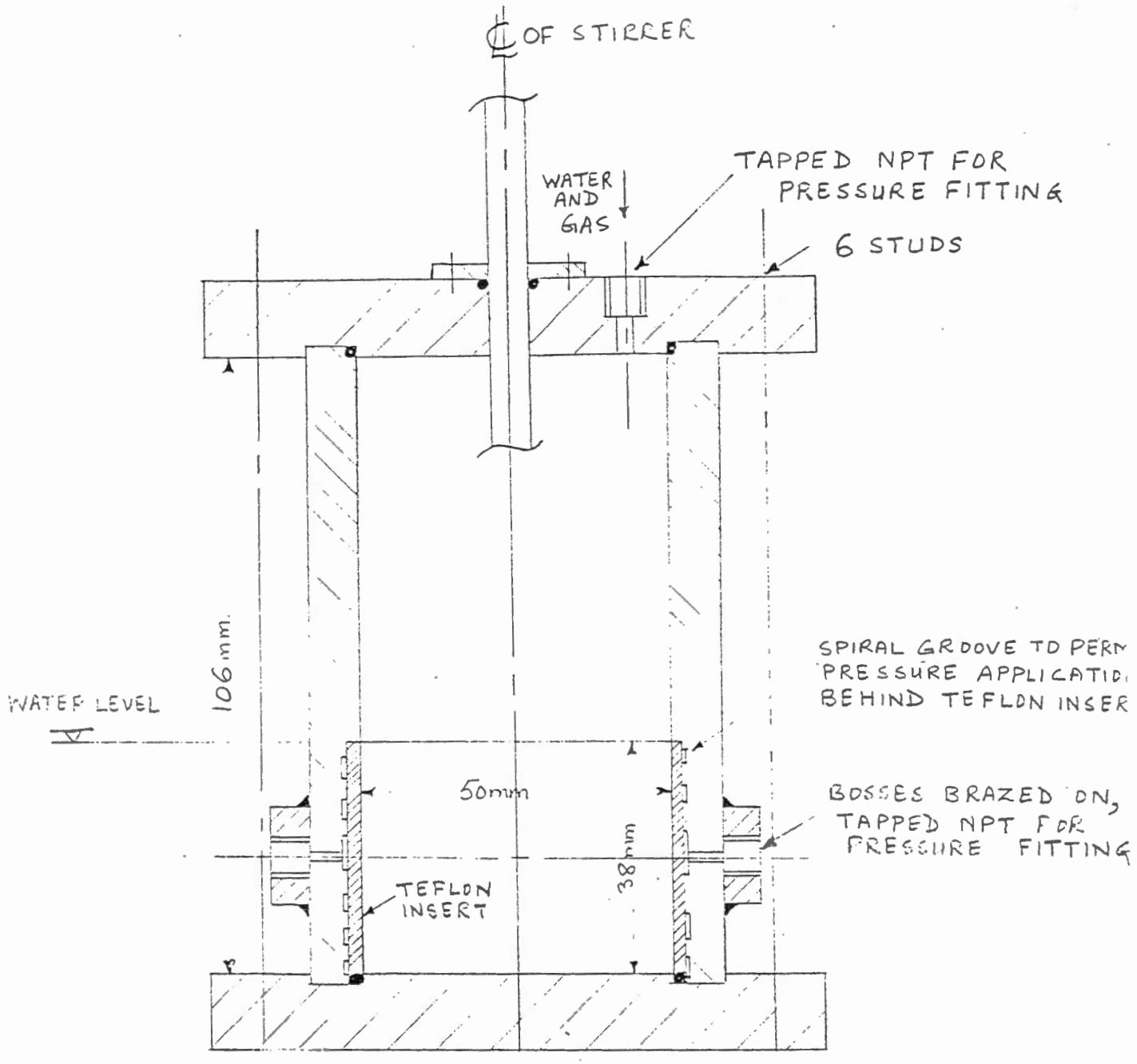

FIGURE 1. LOW PRESSURE (1MPA) CELL FOR FORMING HYDRATE SPECIMENS.

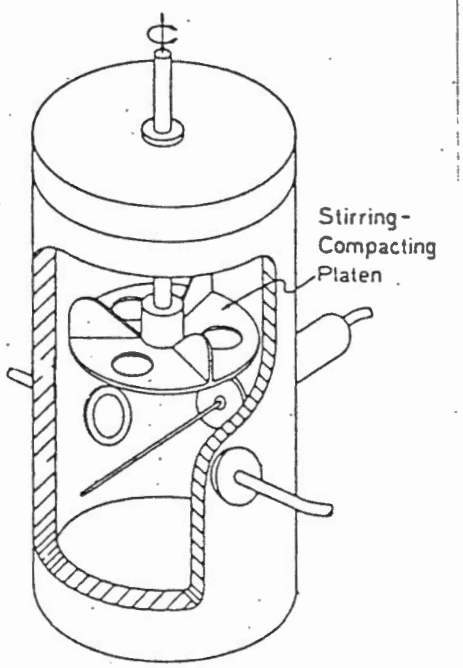

FIGURE 2. STIRRER WITH STIRRING-COMPACTING PLATEN

(after Stoll and Bryan, 1979)

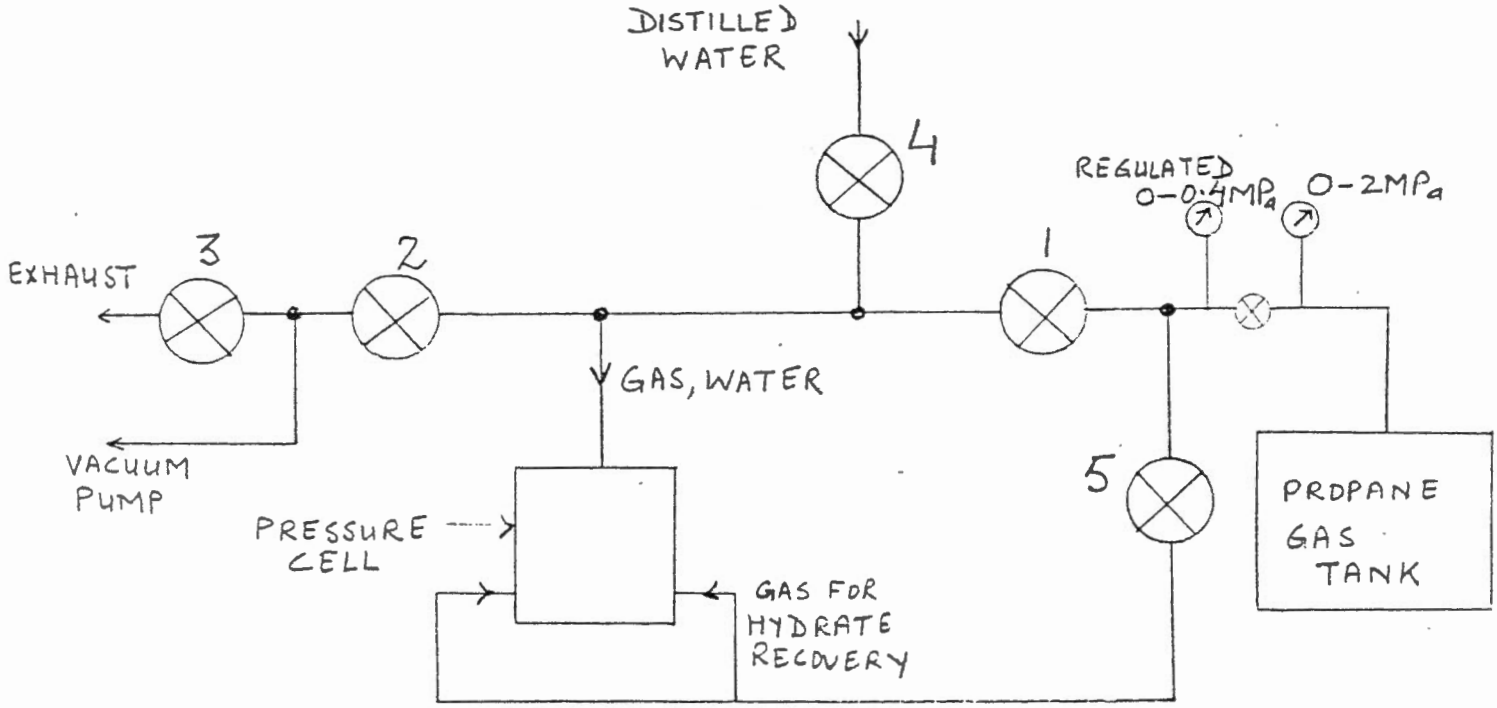

FIGURE 3. SCHEMATIC DIAGRAM OF THE APPARATUS.