

HIGH PRESSURE LIQUID WATER PYROLYSIS OF SOURCE ROCKS TO INVESTIGATE HYDROCARBON GENERATION IN GEOLOGICAL BASINS

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Hydrocarbon generation in geological basins is generally simulated using laboratory pyrolysis experiments in which the source rock is heated in either a vapour or a mixed water-vapour phase. Pyrolysis systems can include open systems in which inert gases are used to heat the samples in an oxygen-free environment (e.g. Rock-Eval), or closed systems with the vessels containing either sample-inert vapour (e.g. MSSV), or sample-water-inert vapour mixes (e.g. hydrous pyrolysis). However, in geological basins, source rocks mature under water saturated conditions with the water being either hydrostatically pressured or overpressured. Previous investigations into the effects of pressure have generated some conflicting conclusions; some studies conclude that pressure has no effect, while others suggest that pressure is significant. Much of the confusion about the effects of pressure arises from the failure to appreciate that the physical characteristics of the pressure phase (compressible vapour versus incompressible water) plays an important role in determining whether the pressure exerts a significant control on the reactions being studied.

Using a stainless steel pressure vessel rated up to 500 bar (*ca.* 7000 psi, 50 MPa) at 350°C, both liquids, vapours or mixtures of the two can be used to pressurise the vessel; this configuration enables the effect of both the pressurising phase and the amount of pressure to be evaluated. A source rock containing an immature Type II kerogen was used. The amounts of bitumen and gas generated, together with the gas composition combined with TOC, Rock-Eval, py-gc and vitrinite reflectance data from the solid residues, were used to determine the degree of transformation. The temperature regime was chosen to produce conversion of the kerogen into carbonaceous residue, bitumen and gas, while preventing cracking of the bitumen to oil and gas and any potential secondary cracking of oil to gas.

The results show that the amount gas generated rises to a maximum as the water volume is increased from 0 ml (anhydrous) to 10 ml (steam) (Fig.1). Further increasing the

water volume towards 30 ml, but still retaining steam vapour conditions produces a significant drop in the volume of gas generated, and this reduction continues as the pressure phase changes from steam to pressurised water. The amount of bitumen generated also changes with water volume and with the water phase, initially increasing from anhydrous to steam vapour, before decreasing as the pressure phase becomes entirely liquid (Fig. 1). Both bitumen and gas generation therefore appear to be retarded in the presence of pressurised water compared with the amounts generated under either anhydrous or steam conditions. Studies on the solid residues after pyrolysis show that both the vitrinite reflectance and py-gc data indicate that the source rock heated at 500 bar is less mature, and retains more of its original potential than samples heated under either closed anhydrous or closed hydrous conditions. The conclusion is that water pressure results in the retardation of maturation and hydrocarbon generation relative to the conventional anhydrous or hydrous conditions used by geochemists.

The reasons for the retardation of the volumes of hydrocarbon that can be generated under water pressure will be discussed, as will the implications for modelling hydrocarbon generation in geological basins.

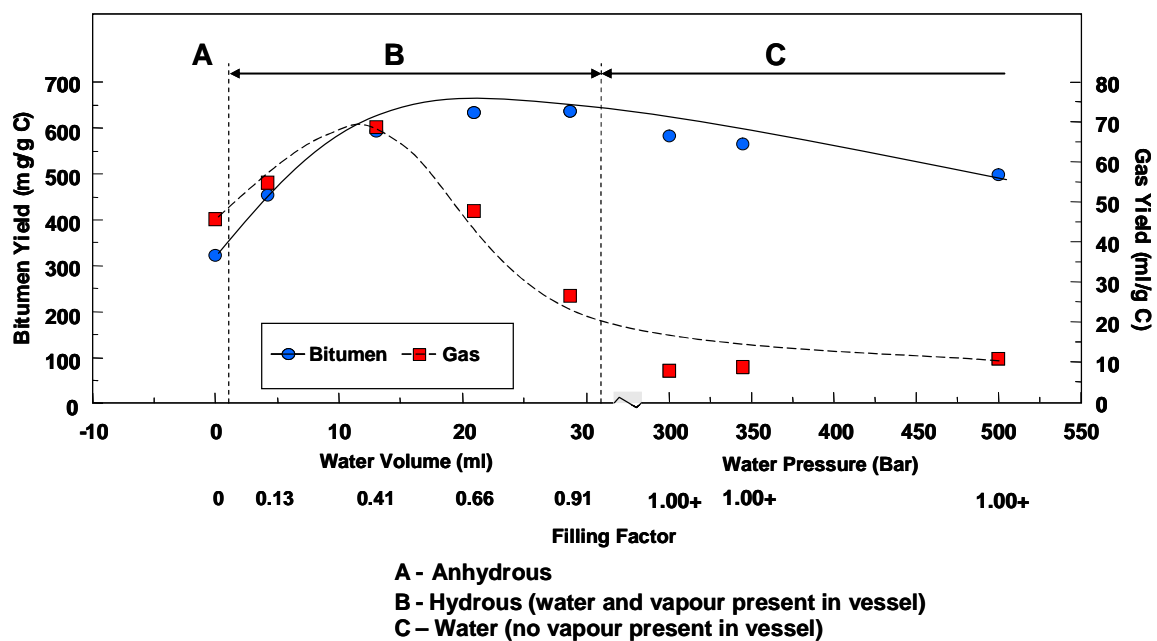


Figure 1. Variation in bitumen and gas yields as a function of pyrolysis conditions