of paramount importance in determining the laminar or turbulent nature of the flow. Thus it seems that $f/2$ has a reasonably constant critical value irrespective of the shape of the cross-section.

A physical interpretation of the significance of the factor $\sigma/\rho\bar{v}^2$ is that it represents the ratio of the shearing stress at the solid boundary to the momentum per unit area of the section. In the early stages of laminar flow the shearing stress σ is sufficient to ensure that eddies are not created, but if the mean velocity $\bar{v}$ then rises gradually, the denominator, $\rho\bar{v}^2$, increases more rapidly than the numerator σ, thus causing a drop in the value of f which continues until a stage is reached, marking the onset of turbulence, when the shearing stress is insufficient to overcome the effects of the inertia. Further resistance is then developed in the form of eddies.

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ENGINEERING

Detonability of Nitroglycerin contained in Porous Rock

IN the course of experiments to determine the feasibility of using liquid explosives to enhance the productivity of oil- and gas-bearing sandstones after hydraulic fracturing, it has been found that dry porous sandstone could imbibe sufficient nitroglycerin-ethylene glycol dinitrate (50–50 NG-EGDN[1]) to yield a detonable charge.

The rock used was Berea sandstone of density 2·2 g/cm³ when dry. Imbibition tests with both water and NG-EGDN showed that this rock is capable of holding 11–13 per cent of its own volume of liquid, although comparison of its bulk density with that of crystalline silica indicates that about 17 per cent of the rock volume is void space.

The rock samples were 2 × 2 × 6-in. blocks which were dried at over 100° C for more than 16 h. They were then immersed in NG-EGDN for several hours. It was found that the rock absorbed 6·6–7·4 per cent by weight of the explosive after 2 h immersion, and that this could be increased to 8·2 per cent by immersion for 48 h.

The detonability trials were instrumented with an expendable pressure transducer having a useful range of 1–70 kbar located at the downstream end of the charge and a continuous, pressure-actuated detonation velocity probe for measuring detonation rates along one side of the charge. Data were recorded oscillographically.

The initiator consisted of a No. 8 electric blasting cap and either a 7·5 or 15-g tetryl pellet (0·75 in. diam. × 0·5 in. long or 0·75 in. diam. × 1·0 in. long); in one case which detonated, there was an additional booster consisting of a reservoir of NG-EGDN 2 in. square and 0·75 in. deep, holding 73 g. For each trial using NG-EGDN, a corresponding test was made using water as the imbibed medium in order to determine the response of the instrumentation to the inert shock transmitted from the donor. In no case was this shock sufficient to actuate the instrumentation, although the sandstone, which was quite frangible, was completely shattered.

Samples with up to 7·4 per cent NG-EGDN did not detonate, although it is possible that the booster was inadequate in these cases. With the NG-EGDN reservoir and with a sample that had absorbed 8·2 per cent NG-EGDN, the measured detonation rate was 4·7 mm/μsec. The record from the pressure transducer was slightly obscured by electrical ringing, but a pressure in excess of 25 kbar was indicated.

Thus, it appears that nitroglycerin, absorbed into a solid, porous, inert matrix, is detonable in concentrations as low as 8 per cent by weight; the resulting system, while insensitive, has an unexpectedly high velocity of detonation. This may be compared with the behaviour of gelled NG absorbed in sodium chloride (density 1·37 g/cm³) where the detonation rate with 15 per cent NG in 4·45-cm diam. is 1·55 mm/μsec (ref. 2).

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[1] Commercial nitroglycerin usually contains EGDN to depress the freezing point and such mixtures are referred to generically as 'nitroglycerin'.
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CRYSTALLOGRAPHY

Structure of Calcium Oxalate Monohydrate

ALTHOUGH details of the structure of some of the hydrates of calcium oxalate have been reported[1,2], the monohydrate is less amenable to crystallographic analysis, since the synthetic salt[3] precipitates as a finely divided powder and the naturally occurring mineral whewellite usually contains impurities[4,5]. Calcium oxalate occurs widely in biological subjects, however, and in plants, where X-ray diffraction powder diagrams have been used to distinguish the various hydrates[6,7], crystals of optically visible size are commonplace[8]. In the course of our investigation of the nature of calcium oxalate in plants, we have been able to isolate crystals of the monohydrate of sufficient size to permit complete measurement of the lattice.

The crystals used in the work recorded here were separated from the leaves and stems of *Yucca rupicola* Scheele collected from a native habitat near Oak Hill, Texas. Calcium oxalate monohydrate is present as an intracellular deposit[9], either in the form of solitary styloids (in the case of the largest crystals) or as smaller needle-shaped crystals in the raphide bundles. The crystals were prepared by triturating the chopped tissue in 95 per cent ethyl alcohol in a high-speed blender, followed by filtration through coarse muslin to remove cellular debris. The filtrate was centrifuged to separate the denser oxalate from the lighter organic substances and the precipitate was resuspended in fresh alcohol and recentrifuged repeatedly until the sediment consisted principally of whole or broken crystals. Samples of the total sediment, and samples of representative groups of the larger crystals selected with a fine glass needle, were examined in a cylindrical X-ray diffraction powder camera. A few specimens of the largest and most perfect crystals, up to 200μ long, were selected under a low-power polarizing binocular microscope, mounted on a fine glass fibre and subjected to single crystal analysis.

Single crystal X-ray diffraction data obtained with Weissenberg and precession cameras using copper K_α and molybdenum K_α radiation can be indexed on the basis of a monoclinic cell; $a = 6{\cdot}61$ Å, $b = 14{\cdot}46$ Å, $c = 10{\cdot}07$ Å and $\beta = 116{\cdot}5$. The $h0l$ diffraction data permit also the choice of $\beta = 109{\cdot}4°$ which is closer to the previously reported values of 107°; the cell parameters then become $a = 6{\cdot}28$ Å, $b = 14{\cdot}46$ Å and $c = 11{\cdot}10$ Å. There are eight formula weights in the unit cell and the calculated