Letter from the CIS

By Alex Yelshin

Can cake compressibility be examined at the nonequilbrium thermodynamic position?

Compressibility is an important factor in describing thickening, dynamic membrane formation, filtration, centrifugation or squeezing. It is characteristic of compressible cakes that there is a change in their porosity from the upper boundary of the cake into the cake, under the effect of newly formed underlying layers and the change of hydrodynamic conditions inside the pores in the cake.

The problem in describing the cake properties is as follows. Existing empirical equations can be used in the limited range of compressional stress P_s (*i.e.* the effective pressure) acting on the cake skeleton. The lack of a method for interpreting the cake properties over a wide range of changing values of P_s (*i.e.* from P_s above zero to $P_s \gg 0.1$ MPa) deprives us of the possibility of effective control of the cake properties, and so we cannot assure a high level of effectiveness of separation equipment.

It may be interesting to perform the analysis of the cake compressibility phenomenon at the position of thermodynamic nonequilibrium. In this case the critical value of P_s can be considered as the point of bifurcation, when the dependencies of the cake properties on the effective pressure change. For example, it can take place when P_s changes from a low value of P_s to moderate values of P_s, or from a moderate value to high P_s.

There are preconditions for this. A compressible cake can be considered as an open thermodynamic system, which is described by nonlinear dynamic equations. Inside this system the cooperative movement of particles takes place when the range of parameter deviation from equilibrium reaches a critical value. As a result the system passes from an unstable position to a stable position, and this is accompanied by the generation of a more regular structure.

The value of information entropy can be used as a measure of the regularity of the cake structure. Thus the cake structure is more regular if the information entropy is smaller.

The processes in the cake under the action of P_s can be described as follows. Changes in the cake properties are developed in the thermodynamic branch of solutions when small systematic deviations from equilibrium take place in the processes. The resulting variations in the cake structure are obtained by continuous deformation of the equilibrium structures, and therefore have a considerable similarity to them.

However, after some critical value of P_s is reached, the thermodynamic branch of solutions becomes unstable. In this case any small disturbance takes the system from a thermodynamic branch to the new status, which has a greater regularity of structure (*i.e.* a bifurcation of solutions). We can expect that near the critical value of P_s a new solution would depend on the non-analyticality of P_s, which is most typical for the critical point when the value of P_s is high.

In all likelihood, further research into the theory of compressible cakes from the point of view of nonequilibrium thermodynamics will add substantially to our understanding of the mechanism of cake deformation in hydromechanical processes.

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'Pollution solution . . .' continued from page 139 . . .

The Stansted requirements

The primary need was to ensure that all rainwater — and the pollutants carried from the various trunk roads, aircraft maintenance and parking areas — was rendered suitable for returning to the region's natural water systems. This meant that aviation fuels, lubricants and other oils were required to be reduced to a level of less than 5 parts per million by removing oil droplets greater than 150 μm in one TPS installation, and less than 10 parts per million (95% of droplets in the range 90–150 μm) in a second TPS installation. These figures were based on actual specifications and predictions by Hyde's own laboratory, which were comfortably achieved to the total satisfaction of both the Stansted Airport authorities and the contractors.

The installation

The two Tilted Plate Separator installations are set into engineered separation ponds within the overall drainage system. The larger of the two systems consists of 16 plate packs in concrete cells, twin inlet channels with vortex tubes, and a centrally positioned outlet channel. This installation has a maximum flow handling capability of up to 535 litres/second. The smaller separator unit consists of three plate packs in concrete cells, with a flow handling capability of up to 60 litres/second.

All rainwater from the Stansted Airport complex and the surrounding roadways is pump-fed through the system and three balancing ponds. After treatment, the water is eventually returned to the natural water system. To ensure the best consistency in water quality, sampling and testing is carried out by an independent laboratory on a fortnightly basis.

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