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Interaction between a percolation network and a cubic cavity

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The intersection between a percolating network of fractures modeled as polygons and a cubic cavity is important for the safe storage of wastes in a fractured medium. The cavities where the wastes are stored should not intersect the percolating network of fractures which may exist, or these cavities should not enable a fracture network to percolate.

The fractures are hexagons inscribed in a circle of radius R which are uniformly distributed in space and isotropically oriented. N_{fr} is the number of fractures generated in a finite unit cell Omega of size L̂3. The fracture density is conveniently represented by the dimensionless density rho ’ which is the average number of intersections per fracture with the other fractures [1].

In addition, a cubic cavity C formed by six squares inscribed in a circle of radius R_s is randomly located in Omega.

N spatially periodic networks are generated. Generally, N is equal to 500. Among these N networks, N_p percolate and the cavity intersects one or more fractures in N_{rc} realizations; no fracture-cavity intersection occurs in N_{nrc} realizations.

Moreover, when the network alone does not percolate (which occurs in N_{np} realisations), the set composed by the hexagons and the cavity percolates N_{npc} times.

These quantities and the corresponding probabilities were systematically calculated as functions of L’ = L/R , R’ _s = R_s/R and rho’. An important quantity is the conditional probability Pi_c that the percolating cluster intersects the cavity when it exists. It could be extrapolated to an infinite cell size L’. This conditional probability is an increasing function of rho’ and of R’ _s.

The probability Pi that an object X intersects the fracture network with the density rho is given by the expression Pi=1-exp(- rho V) where V is the excluded volume for the object X and a fracture. This quantity is obtained for a cube.

This prediction is in good agreement with the conditional probability Pi_c for large rho’ or small R_s. However, Pi and Pi_c are not totally comparable because Pi is the probability for the intersection with the whole network and not with the percolation cluster only.

Additional data will be presented and discussed.