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Modeling of Hydrocarbon Reservoir: A Fractal Approach

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Many oil fields in the world including India are in the danger of being prematurely abandoned even before the entire oil in place is fully extracted. In Norway and Canada so far about 60% of the oil in place in sandstone fields is being recovered. In many other countries the recovery rates are even lower hovering at around 35%. The average recovery factor for oil fields in India (after excluding Ankaleswar and Nahorkatiya oil fields) lies between 24% and 26%. It may, thus, be seen that a larger proportion of the oil reserves is not being recovered. If newer and more effective techniques are not developed and implemented this valuable non-renewable resource will not be available for the benefit of the humankind. There is, therefore, a need for intensification of research efforts for increasing the recovery rates.

Success of any secondary recovery method depends upon several factors. Hence, intensive research work is under way for enhanced oil recovery (EOR). Amongst the existing EOR methods the most popular and cost effective method is water-flooding technique. For achieving a greater success of enhanced oil recovery methods it is imperative that we have a comprehensive knowledge of the reservoir in terms of its geometry and geology. Petroleum reservoirs are natural features having zig-zag boundaries, which hardly conform to a Cartesian coordinate system. More often reservoirs can not be modeled with planer boundaries and the shape of the reservoir must be taken into account for its characterization. Hence, the prime essence of reservoir modeling lies in generation of such a natural volume, which conforms to the natural reservoir settings, which is fractal in nature.

We have developed a method to compute a grid that conforms to external and internal boundaries using Voronoi tessellation. The Voronoi tessellation technique can generate realistic fractal volumes, as we desire with the help of a few parameters known as Voronoi centers. The placement of these centers decides about the structure of final fractal volume and hence can be used to improve state-of-art reservoir gridding and modeling techniques. Small fractal volumes forming the whole reservoir shape can be assigned different values of varying physical properties to take into account the heterogeneity. Implementation and monitoring of any secondary recovery method, like water flooding, in a timely way is necessary to improve the reservoir performance. The hydrocarbon reservoir is divided into many flow units; connectivity of these flow units can be studied by using Renormalization Group Method to monitor the fluid flow in the reservoir.