Mathematical study of biofilm spread

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Biofilms are bacterial aggregates encased in a self-produced polymeric matrix which attach to moist surfaces and are extremely resistant to chemicals and antibiotics. Recent experiments show that their structure is defined by the interplay of liquid transport and elastic deformations within the biofilm, in response to the cellular activity and the interaction with the surrounding environment [1, 2, 3]. We propose a two phase mixture model for biofilm spread, which couples conservation laws for the fluid and solid fractions with reaction diffusion systems for nutrients and other relevant chemicals. To describe the evolution of the biofilm boundary as it grows we perform a thin film approximation. Our asymptotic expansions yield lubrication type equations for the film/air interface. The resulting equations admit special solutions with a selfsimilar structure which represent the motion of the advancing boundary. We are able to solve numerically the equations in particular cases finding reasonable agreement with the selfsimilar solutions [4, 5, 6].

References

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