Use of a Thermographic Approach for Non-Destructive Evaluation in the Field of Fracture Mechanics

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The processes of generation and moving of a crack under both cyclic and static deformation of a material are accompanied by thermal phenomena. In the domain of damaging (top of crack), it may be considered as if a peculiar heat source is acting. That heat source forms a passive thermal field on the surface of the testing object, which has much information about damage processes. As a direct damage criterion we used S - increment of specific entropy produced in the top of the crack for one cycle of oscillation or for some short period of time. We worked out a new thermographic method definition of the static crack resistance characteristics if destruction is plastic or elastic-plastic. Our thermographic P-S diagram, unlike the traditional P-V diagram, has a distinctive curvature near a characteristic point Q. (P is the force stretching the sample; V characterizes the widening of the crack). This curvature has a clear physical interpretation, because before the beginning of crack growth, a more or less considerable plastic zone forms at the top of the crack, therefore the temperature is increased sharply. That is why the thermographic approach allows us, at first, to fix the distinctive point Q and then to calculate static crack resistance characteristics with more accuracy than traditional methods. The thermographic approach allows us also to increase the accuracy prediction of cyclic lifetime of details having initial cracks and to widen the range of details for testing. As a part of building the kinetic fatigue diagram, we connected the velocity of crack growth (VCG) with the parameter S, but not with the traditional parameter CSI - coefficient of stress intensity. CSI is not a sufficient identifying parameter of VCG because CSI doesn't consider such processes as formation of a plastic zone at the top of a crack, possible branching of a developing crack, and so on. Using the parameter S overcomes these problems. The trained non-destructive evaluation is successfully used at some industrial enterprises in Russia.