Now, because the shock waves are curved, each streamline that passes through the shock at a given incidence angle will experience a different change in entropy. Hence, the flowfield behind the curved shock will have an entropy gradient such that ∇*s*≠0. As a result, from the well known Crocco theorem,

where *s* is the entropy, *h*0 is the total enthalpy, and *V*⃗  is the velocity, the non-zero entropy gradient would imply vorticity in the flowfield behind the curved shock. Hence, behind any curved shock wave, we will have the conditionThis is all well established and is relatively easy to follow and understand. However, I have a difficult time trying to justify the satisfaction of the [Helmholtz vortex theorems](https://en.wikipedia.org/wiki/Helmholtz's_theorems) to this particular class of problems. The one in question is his third theorem. The third theorem gas as follows:

In the absence of rotational external forces, a fluid that is initially irrotational remains irrotationa

Now the Helmholtz vortex theorems apply to inviscid flows where viscous forces are neglected. However, the curved shock problems described above can easily be established from an invsicid framework, such that the Helmholtz theorems should still apply. So my question is, if the flow starts irrotational ahead of a curved shock wave

yet becomes rotational behind the curved shock wave

because of the entropy gradient, then are we in some way violating Helmholtz's third vortex theorem? Is a curved shock wave somehow introducing a rotational external forces on the fluid elements? The common phrase regarding the third vortex theorem states that fluid elements initially free of vorticity remain free of vorticity, but this doesn't seem to be the case here. Anyways, I was hoping to get some clarification or perhaps I am missing something very fundamental.