Indian Institute of Technology Kanpur

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Technology Enhanced Learning

Course Title

Environmental Degradation of Materials

Lecture – 25
Broad Subject: Crevice corrosion

By
Prof. Kallol Mondal

Dept. of Materials Science & Engineering

Now we discuss crevice corrosion, so the crevice corrosion is a particular form of corrosion which is highly localized in nature and of course there is a galvanic effect that is associated with it because of change in concentration of reduction species or the species which gets reduced and this happens in the crevice section of a particular metal or structural object which is under use. Let's say I have a bolt, when you use a bolt it's basically this is basically by bolt surface, the top part of the bolt, okay, so let's say this is my bolt part, now only let us consider the half part of it, I will not consider the whole part, the half part let me draw, so this is the crevice a small opening where we have a solution or corrosive, corrosive which is nothing but the electrolyte where corrosion is going on, and in this section there is a small opening which is nothing but the crevice we have stagnant condition, though the outer part, rest of the part let's say this is inside the solution this entire stuff inside the solution the rest of the part there could be turbulence or water or the flow in the corrosive but this part since it is a very small opening where the solution is going, solution is there already due to seepage and all those things but here we don't have much of turbulence and it becomes stagnant, and that time in this zone there could be a possibility of a deep corrosion attack in the body and that corrosion attack could be so violent that since this machine, if the system is under pressure or the tension then there could be failure or fracture so the crevice corrosion always happens in the crevice part of a structure and if I would like to define this crevice corrosion, the classical way to define is intense definition, intense localized corrosion frequently occurs within crevice and other shielded areas, on metal surface exposed to corrosive, and the shielded area means we have a stagnant liquid there, so this is the definition of crevice corrosion and this type of corrosion of course we have already seen this type of corrosion is associated the stagnant condition of the solution that is existing in the crevice.

Now what could cause crevice corrosion? The cause would be one is these are the causes, one is a narrow space between metal to metal or metal or nonmetal contact areas then we can have it

this crevice corrosion near crack, cracked part or it can also happen and it happens near in the sea part which is below the sea level, below the water level that is due to accumulation of bio fouling deposit that could lead to crevice corrosion and there could be possibility of deposition of dirt, mud or other deposits.

So let's say dirt, in a water tank this is water tank, if we have a small dirt which is falling and staying at the bottom, then we can create two crevice, this is one crevice this is another crevice where water can remain stagnant and it can lead to a localized corrosion in this zone and there could be a severe corrosion in this zone compared to the other surfaces of the mild steel tank, so this is the definition of, this is the deposition of dirt effect or it could be possible let's say some, bolt which has become loose and then fallen on the bottom of the tank, now you also see there is a crevice formation, so this is also another crevice so corrosion can happen here, so all sort of deposits like this they can cause crevice corrosion.

So now we have to see what are the factors that affect crevice corrosion? Before we go to the mechanism of crevice corrosion the factors which are important in controlling the crevice corrosion or effecting, which can affect the crevice corrosion let us just list those factors and we can understand the importance of all those factors once we see the mechanism of crevice corrosion, the factors are if we have let's say this is my crevice, this is one part and this is basically crevice part, now factors, what are the factors? One is bulk solution composition, we will see that the initiation of crevice attack happens because of different oxygen concentration in the crevice and in the bulk of the solution and of course mass transport, mass transport which could be migration or diffusion or convection and we will see that the mass transport which is nothing but the chlorine ion transport in the crevice part in NACL solution or the seawater solution can lead to the autocatalytic nature of crevice attack. Third factor we can have the change in, crevice change in solution nature, change in solution in the crevice it means change in pH, change in chlorine minus ion concentration all those factors, all those affect, all those issues can determine the crevice attack or it could be such that the stagnancy of solution.

Now fourth one is electrochemical reactions, of course what sort of electrochemical reactions are going on that can affect the crevice corrosion. Then we have fifth alloy composition, effect of minor and major elements and this alloy composition also decides whether the material or the alloy would go to passive state or it will remain in active state and if it becomes passive so the another factor is the quality of passivity or quality of passive layer whether it is a very, very stable passive layer or it could be slightly or it could be unstable passive layer those can affect your crevice corrosion. Then we have crevice type, crevice type means whether it is a small gap or it is a crack, all those issues can lead to crevice type, these are falling under crevice type. Now one major important issue is the crevice type is this gap should be such that it would allow the solution to seep in but at the same time that means it should be wider enough to allow the solution to seep in and at the same time it should be narrow enough to maintain the stagnancy, so the two effect, one is wider enough to allow water entry or solution entry and B it should be narrow enough to maintain stagnancy, so these two important parameters will be again seen when we discuss mechanism of crevice corrosion.

Then we have the total geometry, total geometry means whether if the area ratio total geometry then another factor which is total geometry it means that the ratio of this crevice area and the

external area then we can have the number of crevices how many number of such crevice exists on this entire structure so those will definitely affect the crevice corrosion. So now these are the factors which govern, govern the crevice corrosion.

Now let us come to the mechanism of crevice corrosion, see if we see the mechanism of crevice corrosion then there are four steps in the mechanism of corrosion, first step is depletion of oxygen in crevice due to consumption at, conversion in the crevice region, in the crevice region and if we have depletion of oxygen in the crevice region definitely we will see that we are coming across a galvanic effect as well as we have area, unfavorable area effect this will come into this particular section. Second stage would be increase of acidity in the crevice and this is happening because of hydrolysis. Third stage, if the system is passive metal that case there could be possibility of passive layer breakdown and this passive layer breakdown that is accelerated due to the increase in acidity in the crevice layer and these two things can club the concept of the, they can use the concept of Pourbaix diagram. Now fourth one is the propagation of crevice corrosion, crevice corrosion with further hydrolysis with added hydrolysis + increase in acidity. So these are the four different stages for crevice corrosion.

We will now see in detail, what are the reaction at different stages and how we have the increase in acidity as well as hydrolysis related phenomena and then breaking down a passive film.

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Camera
Ram Chandra
Dilip Tripathi
Padam Shukla
Manoj Shrivastava
Sanjay Mishra

Editing
Ashish Singh
Badal Pradhan
Tapobrata Das
Shubham Rawat
Shikha Gupta
Pradeep Kumar
K.K Mishra

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Sweety Kanaujia
Aradhana Singh
Sweta
Preeti Sachan
Ashutosh Gairola
Dilip Katiyar
Ashutosh Kumar

Light & Sound
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Hari Ram

Production Crew
Bhadra Rao
Puneet Kumar Bajpai
Priyanka Singh

Office
Lalty Dutta
Ajay Kanaujia
Shivendra Kumar Tiwari
Saurabh Shukla

Direction
Sanjay Pal

Production Manager
Bharat Lal

an IIT Kanpur Production