On a recent trip to Houston, Texas, Stainless Steel World had the pleasure of speaking with Dr. Haidong Zhang, a Corrosion/Materials Engineer. We spoke in-depth about his career which has spanned several different industries including the manufacturing sector, power generation and even oil & gas. We also discussed some of the valuable lessons he’s learned along the way, why it’s so important to work with good welders/contractors and how the mechanical integrity of aging plants is becoming an increasingly popular concept.

By Candace Allison, Stainless Steel World’s North American Editor

What is your background and how did that influence you to become a corrosion/materials engineer?

I am originally from China and I completed my college education there. In 1995, I came to the United States to work on my graduate degree. In 2001, I got a PhD in Material Science, specifically focusing on corrosion and stress corrosion cracking. I have worked in a variety of different industries since completing my education. My first job was in 2001 with Caterpillar Inc., which is in the manufacturing sector. I was an R&D engineer that dealt with corrosion including managing the corrosion labs, doing testing and failure analysis. All things related to corrosion. After that, I worked in power generation for General Electric (GE) in Schenectady, NY for a short period of time before I moved on to work for Occidental Petroleum Corporation in Los Angeles, California. I stayed there for seven years before moving to Houston (where I’m now located).

How has working in a variety of industries been beneficial to you?

It’s helpful as a corrosion engineer because corrosion is never a standalone topic; it’s a pretty comprehensive unit where you have a little bit of everything. You have to know about coating and material selection, failure analysis, inspection and even a little bit about mechanical engineering and material fabrication. Every year in each of my previous jobs has offered me a different perspective on corrosion. So everything I did helped me to build up my expertise and skill sets, so those are all very helpful in terms of being a good corrosion engineer. Working in different industries definitely helps.

What do you enjoy about being a corrosion materials engineer?

A corrosion engineer is at first an engineer. An engineer, from what I was told, is someone who is basically trained to solve problems. Solving the problem is my passion. I try to identify what’s going on, what went wrong and then I provide a solution to resolve the problem so things work properly while also trying to save the company money. That’s basically the most enjoyable part of being a corrosion engineer. I would say that the problem solving is the part I really like, but there are certainly other things I like about being a corrosion and materials engineer. You are involved in different aspects of the process from helping to design, troubleshoot and commission a certain project. Being involved in a variety things and not just focusing on one single aspect is something I really like.

How does your role as a corrosion/materials engineer change depending on the industry you are working in?

Yes, it’s different. For example, in the power generation sector I was working mostly on steam turbines. Basically, I was working on the water chemistry and steam purity for the combined cycle,
power generator. I had to make sure that once everything was commissioned, the steam got to a certain standard. In that role you are looking at the chemistry and the failure mechanism to make sure you don’t create a situation that will cause failure to the materials. In the oil and gas sector, I was more on the maintenance side working on the facility maintenance, mechanical integrity and inspection. I even dealt with regulation compliance and different failure analysis. For example, if a part failed I would try to help them to identify what the root cause was and what the solution would be.

In the manufacturing industry, my first job, I worked a lot on testing. Testing of the materials, testing of the coatings, and some electrochemical testing, which is more on the research side. All of these things are quite different.

Would you say that starting your career in the manufacturing sector was a good learning experience?
Oh yes, definitely it was a good learning experience, especially the testing and failure analysis. Those are the two things I picked up during my first job. Also, at that time, I was working with the National Association of Corrosion Engineers (NACE), I have been with them since 1996, and I have two certificates from them. One is Material Selection/Design Specialist, which I received during my first job because I helped them with material selection. Using the right material is one of the things I achieved early on and that is pretty critical. It’s actually a really good learning experience. At that time I dealt a lot with NACE MR 0175, which gives requirements and recommendations for the selection and qualification of carbon and low-alloy steels, corrosion-resistant alloys and other alloys for service in equipment used in oil and natural gas production and natural gas treatment plants in H₂S-containing environments.

What are some of the specific challenges you have dealt with as a corrosion/materials engineer over the years?
I started working in the oil and gas sector job in 2007 when the oil prices were already going up. Everyone wanted to maximize the capacity of the facility, and put more though the pipeline. The challenge with that is always the priority between mechanical integrity and production. That is, you don’t want to shut down operations but at the same time you also need to do your inspection, especially pipeline inspection, to ensure the oil always stays in the pipe. There are also some compliance requirements you have to satisfy so it’s always the challenge of priority.

If you ask any corrosion engineer, determining priorities is probably one of the things they experience on a daily basis. If you support a new project, your boss will probably always want to lower costs and expedite the timeline. Then you have to make sure that all the materials are right, all the designs are right and you may need to spend money on getting the more upgraded materials, so it’s always a little bit of conflict. But I think every corrosion engineer would deal with those situations and then come up with the solution to do the right thing for the company. So that’s the biggest challenge that corrosion engineers always face I think.

Please tell us about some of the different materials you have worked with
I have worked mostly with the metallic materials like carbon steel, cast iron all the way to corrosion resistant alloys like Inconel, zirconium and Monel alloys (for seawater). I am used to lots of stainless steel of course, austenitic and duplex and sometimes martensitic 17-4 PH, 15-5 PH. I deal with a variety of materials.
I’ve used Hastelloy and Inconel, zirconium and a little bit of titanium but not much. I’ve noticed that duplex stainless steel is now becoming more and more popular because the pricing is going down. Some of the common duplex grades like 2205 right now are not much more expensive than 316, so of course it depends on the nickel price. There is a lot of time for trying to push duplex stainless steel verses austenitic so those are the things I am dealing with.

Regarding the stainless steels you have worked with, are they considered common grades?
For a corrosion engineer, all the materials I’ve mentioned are pretty common. With the stainless steel, the austenitic steel for 304, 316, 317 those are pretty common stuff. The duplex in 2205, 2207 are common as well. Now there is something called super duplex we are starting to get involved in but not quite putting into application. It’s pretty common to bring up the material to the next level of nickel alloy, for example Inconel 625 is not very uncommon, there are a lot of things we use it for. Zirconium is not quite common but it helps to fight oxidation at high temperature so we use it.

Is the availability of any of the materials you work with ever a problem?
There are two things I want to mention on this topic. The first is that logistic-wise, a lot of times when working on...
a maintenance project, it means that you go out and do all the care after something went wrong. For example, if there is a reboiler, if the tube fails and the company wants to put another bundle in there, they want a local supplier to make one. You may want 304 stainless but the supplier just has 316 welded. I’m then asked if this is okay and often I will say, ‘Well in this condition it’s okay so let’s just use it.’ So sometimes, especially for a maintenance type of project, you get whatever is on the shelf because of the time constraint. That is one aspect, but the other aspect is not about the availability of the specific material but rather the availability of a certain fabricator or welder. Some of the stainless steel, especially duplex, if you don’t weld it right, it’s going to pretty much be a promised failure. So that’s what a material engineer needs to consider, whether or not they have a good fabricator or a good contractor who can work with the material. Some contractors only have welders for carbon steel. If all of a sudden you want them to weld duplex stainless steel you need to make sure that someone can confirm that the welder is qualified before you let them work on the material, otherwise it could be even worse. I have had a couple cases where I have gotten the more upgraded metallurgy because I know they don’t have the welder. That’s the availability side I would say: The material availability and also the availability of the people who work on the material. That has been my experience anyway.

Are there any industry trends you have been noticing over the last few years?

There are a couple of things I have noticed recently but not only related to stainless steel but rather in terms of the infrastructure, we are now talking about aging in the infrastructure. Some of the plants and facilities are getting older so you want to make sure that you don’t have an accident. You have to make sure of that. I think most recently the concept of mechanical integrity has become more and more popular. We are using Risk-Based Inspection (RBI), the integral operating window, those kinds of things have become more and more popular. If there is a failure in a plant in a relatively short time, let’s say two years, that’s usually the problem of material selection. You know you probably you didn’t get the right material. But if a failure happens after 15, 20 or 30 years, it is usually because of the operating condition and it could have shifted without people noticing. Sometimes it could shift because of the economy. For example, let’s say the oil prices go up and people want to get more out of the same facility, maybe they put more into the pipeline. In that case, it’s better to set up something like an integral operating window for a facility or certain terminal where you are supposed to operate within a certain window so everything will be kept in order. That’s been the trend in the last 10 years or so. I have been watching in both my previous and current job and I see lots of focus on the mechanical integrity of the facility and looking at the big picture.

What about any trends in terms of materials?

In terms of the material, what I see is that duplex has become cheaper and duplex stainless steel is really good, it is stronger, it lasts longer and it has a much better resistance to stress corrosion cracking than the austenitic stainless steel. As I can see, it will be used in more and more applications especially in the chemical side.