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Flow Assurance

Meeting the Hydrate Challenge – Expert Viewpoint

Zubin Patel, Director of Deepwater and Flow Assurance Engineering at Multi-Chem, a Halliburton service.

Hydrate formation in flowlines is the number one concern for every subsea flow assurance engineer. As exploration moves into deeper and colder waters, the risk of hydrate formation becomes absolutely critical. But what are the industry's latest techniques for managing the risk of hydrate formation? How well do they work, and what can we expect in the future?

To find answers, *Upstream Intelligence* caught up with renowned hydrate prevention expert Zubin Patel, Director of Deepwater and Flow Assurance Engineering at Multi-Chem, a Halliburton service.

Introduction

Once upon a time, the oil industry had a single foolproof solution to the problem of hydrate formation in offshore flowlines: it didn't lay pipelines anywhere that was cold enough to allow them to form.

These days, a combination of geological and economic factors are requiring companies to produce oil and gas from fields with ever greater water depths. And because it's often uneconomical or impractical to put a platform over the wellheads, it's becoming more common to transport oil and gas through subsea tiebacks that may be as long as 90 or more miles. This generally means that temperatures are cool enough, and pressures high enough, to put them within the hydrate forming region, and action has to be taken to prevent plugs forming. As a result, the industry has been forced to take the bull by the horns and make research into anti-hydrate measures one of its top priorities.

Zubin Patel is the Director of Deepwater and Flow Assurance Engineering at Multi-Chem, a Halliburton service, and he's one of the leading experts in hydrate prevention. *Upstream Intelligence* caught up with him to find out what the industry's latest techniques are for managing the risk of hydrate formation, how well they work, and what we can expect in the future.

Number one problem

Patel says hydrate formation is the number one subsea flow assurance problem faced by the oil industry today. This is partly because issues such as the formation of asphaltene, scale and wax have been with the industry for about a century now, and they're understood, whereas that policy of avoiding hydrates means that it's a comparatively novel problem. Secondly, unlike other pipe-blockers, which develop slowly, hydrate formation is often rapid, and prevention can be a matter of fast reflexes. Thirdly, when a plug does form it can take a long time to remediate. Patel says it's possible for remediation to take a year, and for the costs in lost production and extra fees to add up to the tens of millions of dollars.

There are a number of ways to stop hydrates. The simplest is to put a platform in place, but that presupposes a very large and sustainable production volume to justify the CAPEX cost. Then there's the brute force method of heating and insulating the flowline, which is expensive and limited by how much power can be generated on a platform. The chemical version of this approach is to pump thermodynamic inhibitors such as methanol or monoethylene glycol (MEG). These are effective, but both come with substantial drawbacks. For one thing, very high volumes can be required – sometimes as much as a one-to-one ratio.

Patel says, "If you're using methanol it's almost always a once-through system - you inject it, it comes back to the platform, you process the water and it's disposed appropriately. For glycol systems the injection rate is pretty close to the same but when that water comes back with MEG you then have a regeneration system where you boil off the water and you reclaim the MEG. Of course that has a massive CAPEX cost to it, and MEG systems can be problematic with salty water produced from formations."

Methanol also has the significant problem that a certain amount goes to the oil and refineries don't like methanol in their oil. Patel says, "There is a methanol limitation imposed by refineries and that seems to get smaller over the years; in most places it's 25-50 parts per million and it's difficult to stay under that requirement using large amounts of methanol."

Then there are the low dosage hydrate inhibitors (LDHIs), and this is where Patel and Multi-Chem come in, because they are at the forefront of the research and application of these chemicals. They come in two flavours, kinetic inhibitors and anti-agglomerants, and they have many advantages over methanol and MEG. These are simply because they are low dose, so fewer barrels of them have to be stored and pumped, which is a huge advantage on a production platform. Moreover, the lower dose rates of LDHIs means they can treat a much larger volume of produced water versus thermodynamic inhibitors, enabling a longer field life in many cases.

The key to developing LDHIs has been a general advance in understanding the basic science of what happens when the natural gas interacts with water in a flowline. Patel says, "We have much better understanding of multiphase flow, better understanding of phase behavior, hydrate formation and agglomeration and that sort of thing – that's been developed through joint industry projects, university studies, service companies, and producing companies over the past 50 years. We have a much better understanding of the thermodynamics involved, the kinetics of formation, and how to run tests on hydrates and hydrate inhibitors in the lab."

Constant vigilance

By definition, a risk mitigation approach accepts the possibility that the Ming vase will be knocked over, but puts measures in place to catch it before it hits the floor. With LDHIs this involves generating dataflows from oil fields and constantly monitoring them. Patel says: "When you're allowing small hydrate particles to form in your system and you're continuously injecting anti-agglomerants, you have to be continuously monitoring the conditions of each well, each injection valve, the delivery system, the tanks, pumps, filters and umbilicals. You have to always be watching topside separation and continuously updating your modelling as conditions evolve."

And this is something that Patel does on a daily basis, at work and at home. "On some systems I am able to monitor each and every well, each and every pressure and temperature gauge, the injection system, and the pumps. I'm able to monitor all of that remotely from my office and from my home in real time," he says. "I wake up. My lovely wife hands me a cup of coffee, I get onto the computer, log onto the trend data and I check the status of our most critical wells."

"We're in our sixth year of operating this rather complicated system, and so far we have managed never to form a hydrate plug. We've come close a couple of times – when we've had everything from a pump failure to an umbilical issue to an injection valve problem and we've had to take immediate action, and we've got to them in the nick of time. When you're operating in a dangerous region, your reaction time can be a big factor so we have procedures written for what happens if, for example, the injection pump goes down, how long do you have to get it back up and running before you have to start shutting in wells and taking action step number two."

What next?

Hydrates have been actively studied for about 20 years or so, and the industry has learned a lot of lessons on how to deal with them. On the other hand, there is still a long way to go. For example, it is perfectly possible for two equally competent engineers to look at the data from a field and disagree on the best way to produce it.

"That happens all the time," says Patel. "Nowadays, with the understanding level that we have, you usually will find there'll be three or four options that *might* work, and in the pre-FEED stage you will really start to develop and flesh out three or four different scenarios. At the end of that it's usually a team of flow assurance engineers, chemical manufacturers and service companies that sit down and all agree on a solution."

And even with the level of knowledge accrued, it's not completely certain that it will work as planned. Patel says, "You go to flow assurance conferences and most of the speeches go like this: we planned x, y and z and some of that happened just as we planned and we pat ourselves on the back for that, but then unexpected events took place and we managed our way through it and here are the lessons learned."

Patel says this growing willingness among operators and service companies to share experiences has really helped the industry to advance. He adds, "On top of that you have active research going on in a number of areas such as multi-phase flow modelling, computational fluid dynamics – we now have much better mathematical models – and you have chemical companies all trying to come up with the latest and greatest new chemicals and how it can be applied, you have equipment manufacturers and service companies trying to develop better insulation, active heating technologies, and better subsea separation techniques. I think there's still a lot of room in the future to develop even more advanced technologies to better manage hydrate risk."

Zubin Patel earned his PhD in synthetic organic chemistry from the University of Southern California in Los Angeles. He has been working for major oilfield service companies in the area of flow assurance for the past 11 years, specializing in chemical technology development, lab testing, and deepwater field applications of hydrate inhibitors. He has authored technical papers and articles, and is a regular participant and presenter at industry conferences.

Subsea Processing and Flow Assurance Conference 2015

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