

---

**From:** Wayne Miller [miller99@llnl.gov]  
**Sent:** Monday, July 26, 2010 9:09 PM  
**To:** Ratzel, Arthur C; Bob Ferencz  
**Subject:** Fwd: FW: Help with the HYDRO model  
**Attachments:** CC40 Cv Curve 2.pdf; SPE Paper 84961 August 2003.pdf; SPE-88813-PA-P.pdf

**Importance:** High

Art,

Here are the references on the Norwegian HYDRO model that you asked for, and our initial communications.

LLNL is drafting an NDA today for them to consider, for keeping the flow results confidential.

They have offered up to a week of effort pro bono.

Regards,  
Wayne

>X-SpamScore: -13  
>X-BigFish:  
>VPS-13(zz1be0L542N9f18J9370J62a3L9970kzz1202hzz2c21jz2fh5bh34h)  
>Subject: FW: Help with the HYDRO model  
>Date: Sat, 17 Jul 2010 00:01:52 +0200  
>Thread-Topic: Help with the HYDRO model  
>Thread-Index: AcslBuZwusuhY8akQ90AWMDDPKd5XAAHCWsg  
>Priority: Urgent  
>From: <Stale.Selmer-Olsen@dnv.com>  
>To: <miller99@llnl.gov>  
>CC: <rubs@statoil.com>, <rbsc@statoil.com>, <reidar.schuller@umb.no>  
>X-Reverse-DNS: dmz158.dnv.com  
>  
>Dear Wayne Miller,  
>  
>Since we spoke earlier today I have been in contact with Statoil (Dr.  
>Schulkes and Dr.  
>Schüller) regarding running the so-called HYDRO code on the choke flow  
>in the current Gulf oil spill. Statoil is the owner of the HYDRO code  
>after merger with Norsk Hydro.  
>  
>Statoil says yes to assist you and run some cases using the HYDRO code.  
>A contact should be made between you and Dr. Ruben Schulkes in order to  
>move things forward. I expect Dr. Schüller (and possibly myself) will  
>be involved afterwards.  
>  
>Ruben Schulkes  
>e-mail: rubs@statoil.com  
>cell phone: +  
>  
>Reidar B. Schüller

>e-mail: rbsc@statoil.com or reidar.schuller@umb.no cell phone: [REDACTED]  
>[REDACTED]  
>  
>To speed up the process some additional info will be needed in addition  
>to what you already provided.  
>We need a PVT-sim file describing the  
>composition of the well stream, alternatively a compositional  
>description including the C6+ components.  
>We should also know the oil viscosity.  
>We need to know the mass fraction of each component.  
>We need to know the mass fraction of produced water (if present).  
>And of course a definition of the cases you want to run (upstream  
>pressure, upstream temperature, % open choke, internal dimensions of  
>the choke.  
>If you know, also sea water temperature.  
>If I understand right, upstream there is a straight well pipe and  
>downstream the choke exhausts into the ocean at 150 bara.  
>  
>The HYDRO code is based on a choke model that I developed partly inside  
>and partly outside a contract I had with Norsk Hydro in 1992. The model  
>was based on some of the results from my Ph.D. in 1991. The model was  
>initially published in 1995 as:  
>1) S.Selmer-Olsen, H.Holm, K.Haugen, P.J.Nilsen and R.Sandberg (1995)  
>"Subsea Chokes as Multiphase Flowmeters. Production Control at Troll  
>Olje", Proc. 7th Int. Conf. on Multiphase Production, BHR Group,  
>Wilson,A. (ed.), Cannes,  
>7-9 June, pp. 441-466.  
>Norsk Hydro later validated the model against a wider set of  
>experimental data. It was recoded from handling two-component flows to  
>multicomponent hydrocarbon systems and called the HYDRO code model.  
>This resulted in two papers (2003 and 2006):  
>2) R.B.Schüller, T.Solbakken and S.Selmer-Olsen  
>(2003) "Evaluation of Multiphase Flow Rate Models for Chokes under  
>Sub-Critical Oil/Gas/Water Flow Conditions", SPE Production &  
>Facilities Journal, August 2003, Paper SPE 84961, pp. 170-181.  
>3) R.B.Schüller, S.Munaweera, S.Selmer-Olsen and T.Solbakken (2006)  
>"Critical and Subcritical Oil/Gas/Water Mass Flow Rate Experiments and  
>Predictions for Chokes", SPE Production & Operations Journal, August  
>2006, Paper SPE 88813, pp. 372-380.  
>  
>Best regards  
>  
>Ståle Selmer-Olsen, M.Sc, Dr.  
>Associate Director, Cleaner Energy  
>  
>DNV Energy - Natural Gas, Cleaner Energy and Solutions (NCG)  
>Phone: +47 6757 9900 (switchboard)  
>Mobile: +[REDACTED] (direct)  
>Fax: +47 6757 9911  
>E-mail: staale.selmer-olsen@dnv.com  
>E-mail: staselme@online.no  
>Address: Det Norske Veritas, DNV Energy, Carbon Capture & Storage  
>(NCGN0693), P.O.Box 300,  
>N-1322 Høvik, Norway  
>Web: http://\*www.\*dnv.com  
>  
>

>  
>-----Original Message-----  
>From: Wayne Miller [mailto:miller99@llnl.gov]  
>Sent: 16. juli 2010 18:50  
>To: Selmer-Olsen, Ståle  
>Subject: Help with the HYDRO model  
>  
>Dear Mr. Selmer-Olsen,  
>  
>Thank you for talking with me about running the HYDRO model for  
>two-phase flow through a choke valve. We are assisting the U.S.  
>Government and British Petroleum in understanding and stopping the  
>current Gulf oil spill.  
>  
>The well head is about 1.5 km below the ocean surface. The current  
>configuration at the well head includes a choke valve that can be used  
>as the only exit for oil from the well. This choke valve is used to  
>turn off all oil flow so that the pressure integrity of the sealed well  
>can be measured. The well pressure at the choke valve can vary from  
>ocean ambient (~150 bara) when full open, up to ~600 bara when the  
>choke is closed. The choke valve exhausts into the ocean. The well is  
>producing oil and methane at a 70/30 mass ratio.  
>  
>We have modeled the choke valve resistance to the flow using the  
>manufacturers Cv data, and this does not produce physical results as  
>the valve allows too much fluid to pass. I have also tried the  
>Simpson's 2-phase multiplier you described in your paper, but this also  
>allowed too much fluid to pass. I suspect we need a more sophisticated  
>analysis of two-phase flow, perhaps at choked (sonic) conditions at the  
>highest pressures. I am interested to know if your HYDRO model can be  
>applied to this case.  
>  
>The choke valve is a Cameron CC40 plug and cage control choke  
>[http://\\*www.\\*coopercameron.com/content/products/product\\_detail.cfm?pid=](http://*www.*coopercameron.com/content/products/product_detail.cfm?pid=2862&bunit=FLC)  
>[2862&bunit=FLC](http://*www.*coopercameron.com/content/products/product_detail.cfm?pid=2862&bunit=FLC)  
>  
>I've attached the vendor Cv curve for this valve.  
>  
>Please let me know if you can provide HYDRO or even someone to run some  
>cases for us and what kind of agreement this will require. I'm not  
>sure what will be required to set up any kind of a contract for this  
>help, and I will need to have any payment approved here before I can  
>ask you to proceed with any effort requiring payment.  
>  
>Kind Regards,  
>Wayne Miller  
>--  
>~~~~~  
>Wayne O. Miller  
>Thermal Fluids Group Leader  
>Associate Program Leader for Renewable Energy Lawrence Livermore  
>National Laboratory  
>7000 East Ave., L-140  
>Livermore, CA 94551  
>(925) 424-4472  
>~~~~~  
>



```

>
>*****
>*****The contents of this e-mail message and any attachments
>are confidential and are intended solely for the addressee. If you have
>received this transmission in error, please immediately notify the
>sender by return e-mail and delete this message and its attachments.
>Any unauthorized use, copying or dissemination of this transmission is
>prohibited. Neither the confidentiality nor the integrity of this
>message can be vouched for following transmission on the
>Internet.*****
>*****
>
>
>Content-Type: application/pdf; x-mac-type=50444620; x-mac-creator=C74943C8;
>    name="CC40 Cv Curve.pdf"
>Content-Description: CC40 Cv Curve.pdf
>Content-Disposition: attachment; filename="CC40 Cv Curve.pdf"
>
>
>Content-Type: application/octet-stream;
>    name="SPE Paper 84961 August 2003.pdf"
>Content-Description: SPE Paper 84961 August 2003.pdf
>Content-Disposition: attachment; filename="SPE Paper 84961 August 2003.pdf"
>
>
>Content-Type: application/octet-stream; name="SPE-88813-PA-P.pdf"
>Content-Description: SPE-88813-PA-P.pdf
>Content-Disposition: attachment; filename="SPE-88813-PA-P.pdf"
>
>

```

```

--
~~~~~
Wayne O. Miller
Thermal Fluids Group Leader
Associate Program Leader for Renewable Energy Lawrence Livermore National Laboratory
7000 East Ave., L-140
Livermore, CA 94551
(925) 424-4472
~~~~~

```