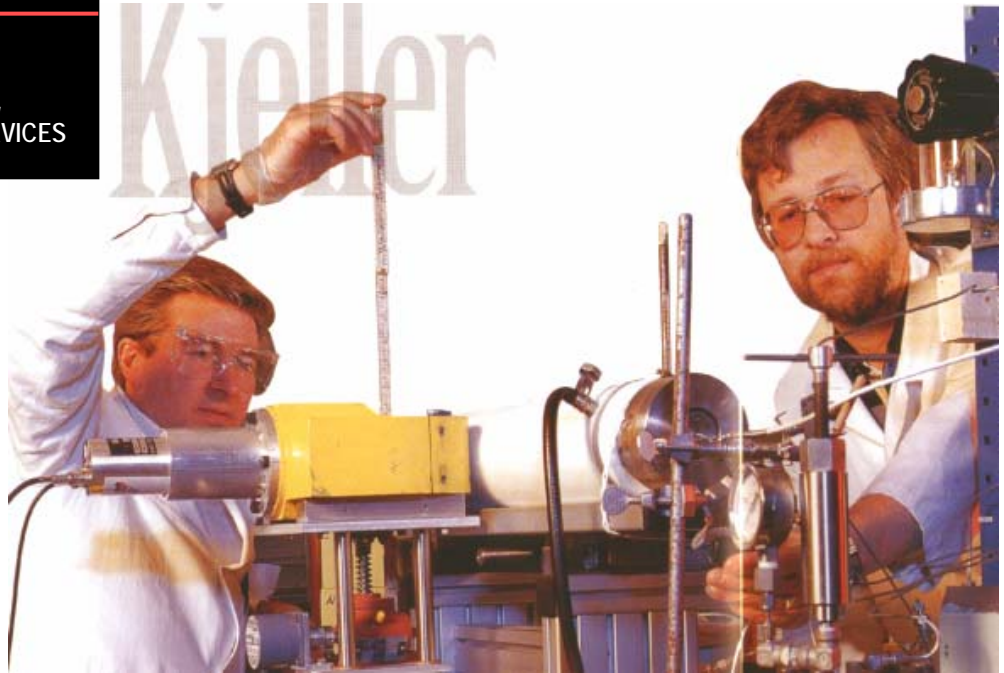


# PETRO

PETROLEUM RESEARCH,  
DEVELOPMENT AND SERVICES

# Kjeller



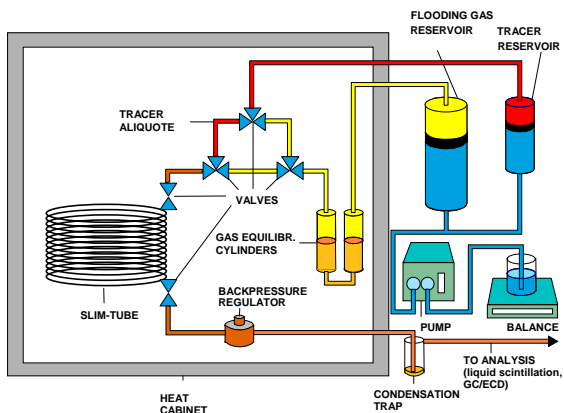
## High pressure flooding equipment for simulated reservoir experiments

•Experiments that simulate fluid flow at reservoir conditions require extensive laboratory equipments. The tracer technology laboratory is equipped with several flow-rigs as shown below

### INSTRUMENTATION

#### *Slim-tube system:*

- A 12 m slim-tube (length can be varied) with inner diameter of 0,5 cm filled with porous reservoir material of various kind.
- Pressure tolerance 400 bar
  - Maximum temperature 120 °C.
  - Tracer injection system based on HPLC pumps, piston cylinders and multiport switching valves.
  - On-line GC analysis and sampling (sample changer) for liquid scintillation counting.



### HIGH-PRESSURE RIG FOR WATER AND OIL TRACERS

#### *Flow-rig for gamma scanner (upper picture):*

Especially designed (low-density material core holder) to optimize the use of gamma-emitting tracers. The tracer flow can be followed non-destructively and continuously by detectors moving outside the core holder in a two-dimensional grid. This enables 2D monitoring of variation in fluid saturation on the core with time.

Gamma-radioactive tracers are available in our laboratory both for the water and oil phases. Also the gas phase can be labelled with short-lived radiotracers thanks to our neighbourhood to the JEEP II reactor at IFE where short-lived radionuclides can be produced on demand.

The rig is also equipped with on-line (flow loop) liquid scintillation (or solids scintillation) detection of beta-emitting tracers. All systems are connected to logging tools for pressure, temperature and flow rates controlled by PC.

This rig offers unique possibilities to study mechanisms for fluid flow in porous media and recovery mechanisms during enhanced oil recovery (EOR) operations.

*Flow-rig based on a slim-tube system for examination of gas tracers*

## DEPARTMENTS AT IFE

### HALDEN

COMPUTERISED OPERATION SUPPORT SYSTEMS  
DATA PRODUCTION AND EVALUATION  
EXPERIMENT ENGINEERING  
INDUSTRIAL PSYCHOLOGY  
OPERATION CENTRES  
RADIATION PROTECTION  
REACTOR OPERATION AND ENGINEERING  
TEST RIG DESIGN AND PRODUCTION  
VISUAL INTERFACE TECHNOLOGIES  
NUCLEAR MATERIALS TECHNOLOGY  
ICT RISK AND DEPENDABILITY

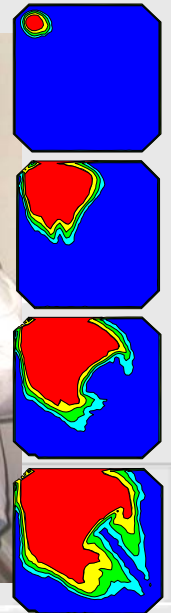
### KJELLER

ENERGY SYSTEMS  
PHYSICS  
ISOTOPE LABORATORIES  
MATERIALS AND CORROSION TECHNOLOGY  
EL. BEAM WELDING/MECHANICAL WORKSHOP  
HEALTH AND SAFETY  
ENVIRONMENTAL TECHNOLOGY  
PROCESS AND FLUID FLOW TECHNOLOGY  
REACTOR OPERATION  
**RESERVOIR AND EXPLORATION TECHNOLOGY**

2D sandstone reservoir for flooding experiments



Gamma-camera for 2D recording of fluid distribution and saturation



Head of Section for Tracer Technology

**Øyvind Dugstad**  
Tel.: 63 80 60 85  
Fax: 63 81 11 68  
E-mail: [oyvind.dugstad@ife.no](mailto:oyvind.dugstad@ife.no)



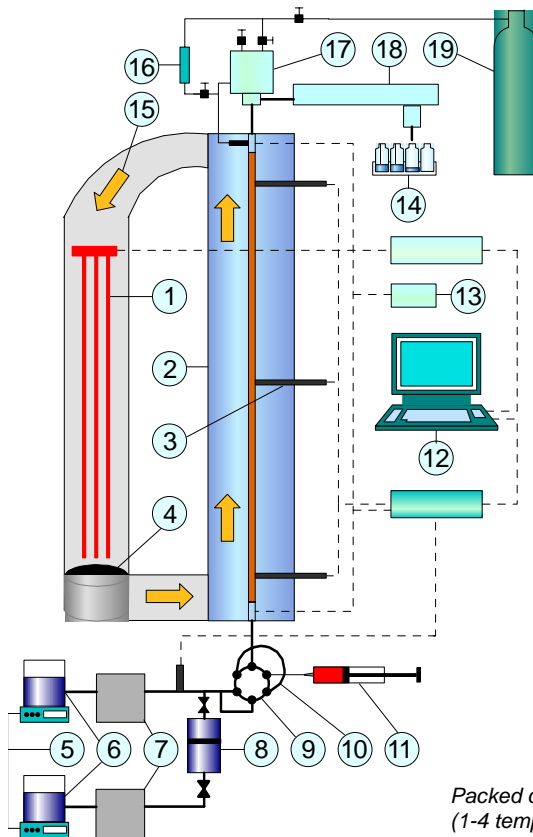
Senior Scientist, Section for Tracer Technology

**Are Haugan**  
Tel.: 63 80 64 46  
Fax: 63 81 11 68  
E-mail: [are.haugan@ife.no](mailto:are.haugan@ife.no)



Senior Scientist, Section for Tracer Technology

**Sindre Hassfjell**  
Tel.: 63 80 61 84  
Fax: 63 81 11 68  
E-mail: [sindre.hassfjell@ife.no](mailto:sindre.hassfjell@ife.no)



## FURTHER MAJOR FLOW-RIGS

### Packed column system :

- 2-meter long column with an inner diameter of 11 mm. The column can be filled with different grain material to simulate the reservoir considered.
- Pressure and temperature limitations as for the slim-tube above.
- Injection and sampling similar to the slim-tube.
- On-line analysis possibilities

### Flow rigs based on Hassler type core holders:

- Various cells are available from the standard 1.5x3" (diameter x length) to larger ones (2x20").
- Core holders of steel, carbon fibers or titanium.
- Temperature and pressure limitations of 120 °C and 500 bar, respectively.
- Flow-rig equipped with injection and sampling equipment similar to the slim-tube
- On-line analysis possibilities

*Packed column applied for studies of tracers (1-4 temperature control, 5-11 injection system, 12-18 sample collection and analyses)*

## APPLICATIONS

The instruments are being applied to study tracer behaviour at reservoir conditions, fluid flow mechanisms in porous media, EOR/IOR methods (polymer flooding), effect of massive gas injection (various gases) and formation damage studies like scale precipitation.

The flow rigs in combination with radioactive tracers and nuclear instrumentation constitute a powerful tool for various sophisticated studies at core scale.