

# UK Fluids Network Short Research Visit

## Slip flows in petroleum engineering and automotive filtration

### 1. Background

Slip flows in porous media have become important in the automotive sector because of the introduction of gasoline particulate filters. Coventry University have an ongoing research programme on filtration flows, and recent experimental results (Aleksandrova et al 2018) show that the slip effect is more important than was previously believed. In petroleum engineering applications the topic has been extensively studied. Prof Jamiolahmady's group have an outstanding track record in studying slip flows in porous media (Moghaddam and Jamiolahmady 2016) at high pressure and constant temperature.

Knowledge transfer between these areas is not straightforward as the permeability and slip in petroleum applications are mostly affected by the porous medium geometry and stresses. In automotive applications, the high temperatures cause gas rarefaction and slip. Thus, while the key non-dimensional groups (e.g. Knudsen number) are similar, the dependence of slip coefficients on the temperature and inertial effects needs to be investigated in more detail.

This was an exploratory visit to establish areas of interest between the two groups (Coventry aftertreatment group and Heriot-Watt Institute of Petroleum Engineering) in slip flow characterisation and modelling.

### 2. Visit overview

**Hosts:** Prof Mahmoud Jamiolahmady and Dr Jingsheng Ma (Heriot Watt University)

**Visiting researchers:** Dr Svetlana Aleksandrova, Dr Humberto Medina, Prof Stephen Benjamin (Coventry University)

**Schedule:**

**Day 1 (20/12/18):** 10 am - Discussion meeting with presentations from Coventry and Heriot-Watt  
2 pm - A tour of Petroleum Engineering Institute facilities

**Day 2 (21/12/18):** 10:30 am - Coventry University seminar presentation "Permeability and slip: challenges in Particulate Matter Filtration Flows"  
11:30 am - follow-up discussion meeting



### 3. Visit outcomes

A range of future work directions have been agreed as short-term, medium-term and long-term goals:

- A joint paper studying properties of the porous walls typical for automotive filters, using the experimental data collected at Coventry, and pore network or Lattice-Boltzmann simulations by Heriot-Watt
- Hybrid modelling combining continuum model coupled with Lattice-Boltzmann or DSMC - e.g. applied to channel flow with porous walls and suction/injection
- Extra testing with better samples if obtained from manufacturers, with analysis of slip + permeability dependence on the porous medium properties
- A joint grant application for a combination of experimental, analytical and numerical studies of generalised properties of slip flows in porous media
- Study of permeability degradation for coated filter walls (e.g. poisoning, high temperature effects)



The initial activities (data and expertise exchange, sample procurement for extra testing, data collection for the porous wall geometry and parameters) have started immediately after the visit.