POLITECNICO DI MILANO

PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 38th cycle

THEMATIC Research Field: DIGITAL TWINS: OPTIMIZED RELIABLE MODELS TO SIMULATE COMPLEX SYSTEMS

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The pipelines and components managing multiphase fluids coming from the hydrocarbon production wells consists of a set of manifolds and separators operating at different (controllable) pressures. The technical solutions are expected to optimize the fluid management at plant level maximizing hydrocarbon production. However, the distribution of the multiphase flow involves an imbalance that cannot be managed and cannot be simulated with standard tools. This imbalance (in terms of flow rates and fluid composition) leads to instability of the multiphase flow (with slug phenomena) which can lead to considerable dynamic loads (with effects on the structural integrity of the manifold) and a non-optimal management of production wells. To manage such physical complexities, it is necessary to use calculation tools that are suitable to treat this complexity in an acceptable computational time. These calculation tools result in a set of concentrated parameter models, ROMs (reduced order models) derived from CFD simulations and models of individual equipment. The models will have to communicate with each other, through an appropriate input-output exchange protocol. All this could be integrated with a control system that is able to optimize the management of the distribution system.
Methods and techniques that will be	This PhD project will investigate how to combine and

developed and used to carry out the research	optimize different modelling technologies, to evaluate the behavior of components of industrial plant working with multiphase fluids.The outcome is expected to be the availability of a computational tools able to manage multiphase flow transport in pipelines and industrial components for upstream and downstream applications. It is expected to develop 3D models as well 1D model interacting each other in term of exchanging information (boundary conditions). All these models must take advantages from HPC opportunities. 3D models are based on CFD codes and focusing on specific geometrical details while 1D models are expected to manage the fluid-dynamics and heat transfer phenomena for multiphase flows at large geometrical scale.The successful candidate will join the research centre of eni spa that provides a collegiate, vibrant, and welcoming environment. Research findings will be published in high-impact journals with the opportunity to present at international conferences **Theoretical tools:** Computational fluid dynamics in multiphase flows, optimization techniques, DOE approaches, uncertainty quantifications, HPC management and data communication. **Computational tools:** CFD code (Ansys), Modelica, Matlab, Python and open-source codes.
Educational objectives	The doctoral program offers advanced training organized in three pillars:Basic Research, which includes methodological courses related to key aspects of theoretical and applied research in engineering and technology of sustainable change.Specific Research, designed to strengthen candidates' knowledge on specific topics aligned with their research interests and increase their presence in the international scientific community through participation in conferences and presentation of their scientific work in academic contexts.Development of the Doctoral Thesis, which allows candidates to develop leading-edge research competencies and produce original scientific work on a topic that contributes to scientific debate and has societal impacts. Periods of study in worldwide recognized research institutions and in eni company are supported by the doctoral school and the supervisor.

Job opportunities	Public and private entities, industrial companies, universities and private research institutes in the areas of energy production, conversion and transmission, rational use of energy and sustainability.
Composition of the research group	2 Full Professors 2 Associated Professors 2 Assistant Professors 7 PhD Students
Name of the research directors	Fabio Inzoli

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activities:Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentations and computer, etc. This amount is equal to 10% of the annual gross amount, for 3 years.

Teaching assistantship:Availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer availability: individual use.

Desk availability: individual use.