Analysis of the Transient Performance of an Annular Linear Induction Pump Using COMSOL

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COMSOL Conference 2019, Bangalore, INDIA

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- ALIP has many similarities with induction motor, in particular, the linear induction motors, yet there are many differences also
- A detailed analysis of ALIP requires solution of Maxwell's equations to take into account the discontinuous magnetic circuit and end effects.

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- The stator consists of three-phase circular distributed winding over the duct. The coils are placed in the slots of laminated stator stacks.
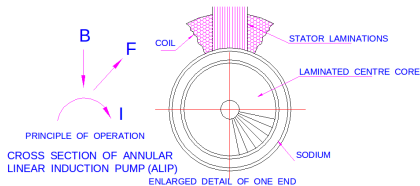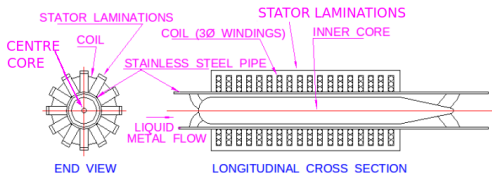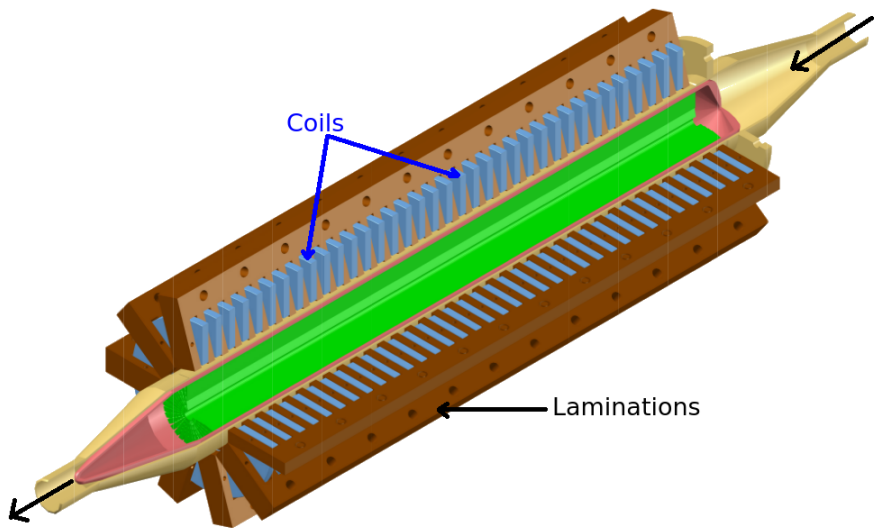
Coils

Laminations

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- In order to achieve this, an axisymmetric 2-dimensional model was made in COMSOL and was solved in time domain.

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Continuity eqn. :

$$\frac{\partial \rho}{\partial t} + \nabla. \left(\rho \vec{v} \right) = 0 \tag{7}$$

COMSOL Model & its Solution
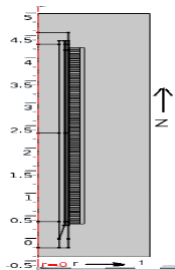
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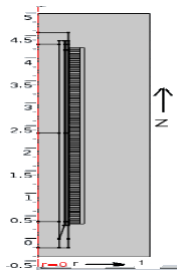
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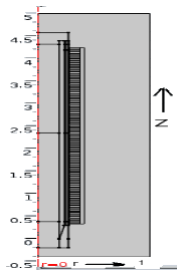
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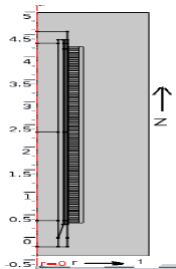
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3. The electromagnetic force produced in the liquid metal is coupled to the fluid flow by adding the electromagnetic force to the Navier-Stokes equation as a volume force.

Sudden decrease in flow

1. In order to analyze the response of ALIP to transients - a sudden decrease in flow is simulated by suddenly decreasing the velocity to half of its initial value.

2. Implemented by using step function in COMSOL

3. The step change is implemented once start-up transients due to in-rush currents have settled down.
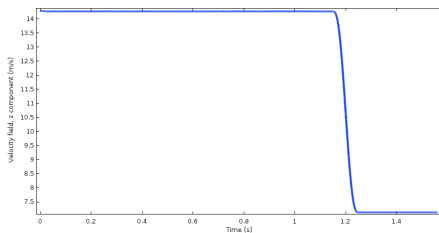
Results
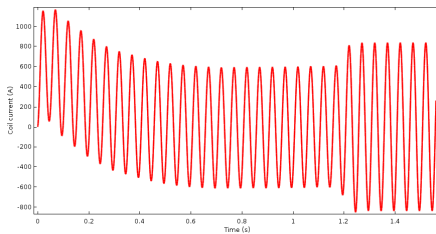
R-Phase Current

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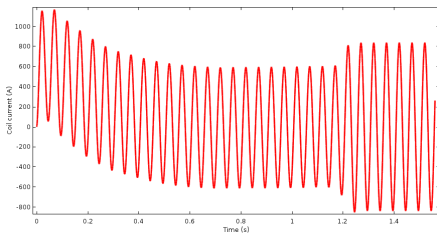
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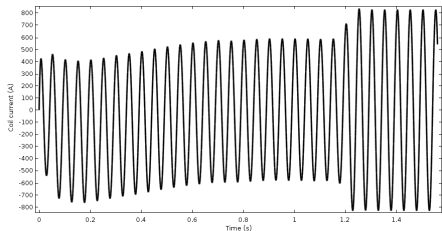
Y-Phase Current

Flux variation
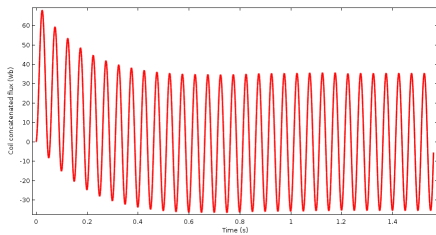
R-Phase Flux

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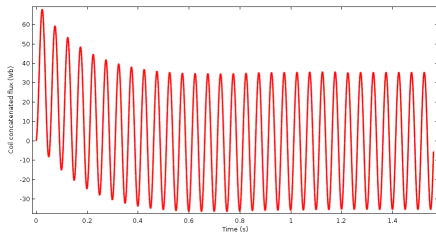
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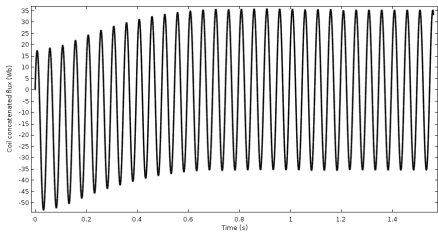
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Power & Developed Pressure variation
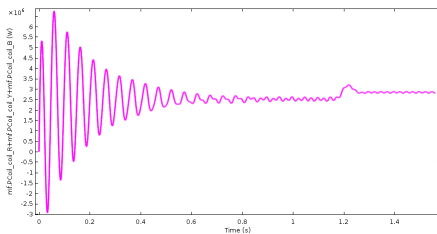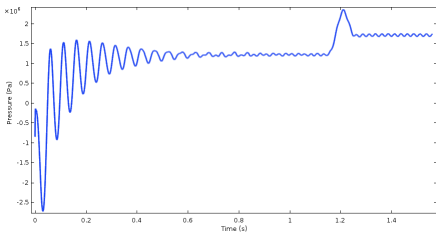

Power
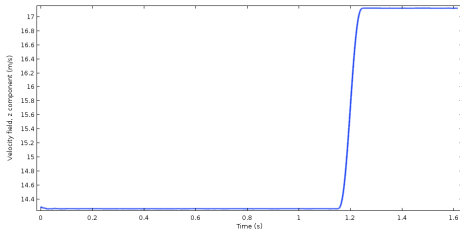
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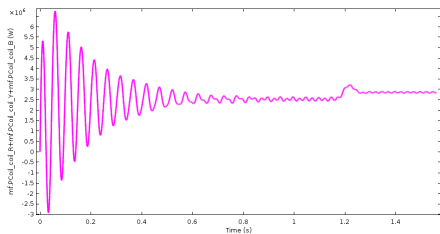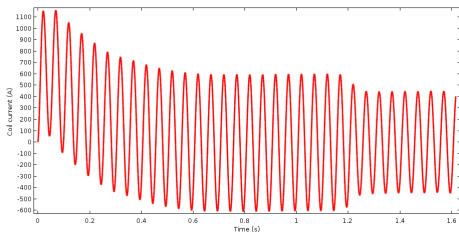

Power

Pressure

Sudden increase in flow

1. Next, a sudden increase in flow is simulated by suddenly increasing the velocity.

2. Again this is implemented by using step function in COMSOL

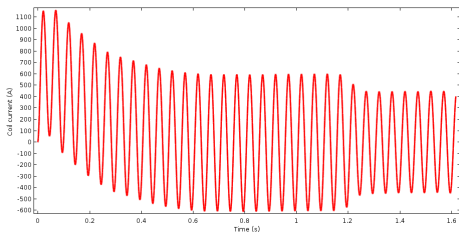3. Here, only a 20 % step increase is implemented so that the pump does not enter into generating zone.
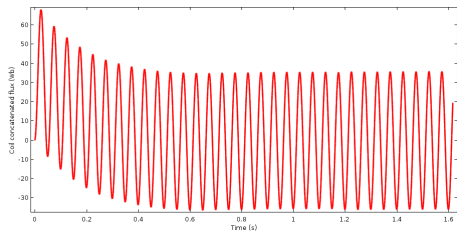
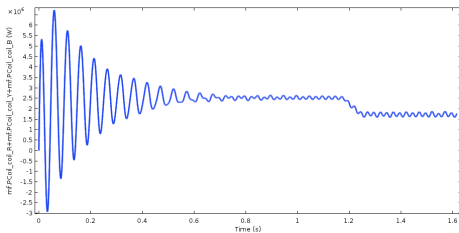*R-Phase current & flux*

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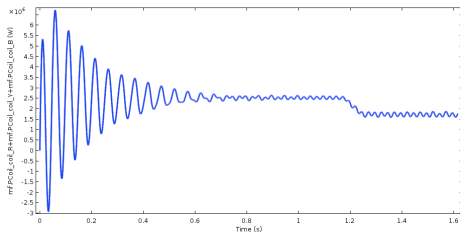

R-Phase Current

R-Phase Flux

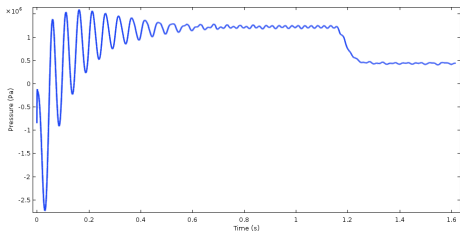*Total Input Power & Output Pressure*

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Future Works

- Fluid-Structure Interaction coupled with magnetohydrodynamics

Thanks