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## V ENCUESTRO Ingeniería de la Energía

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CÁTEDRA DEL AGUA  
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# ACTAS DEL CONGRESO

## V ENCUESTRO DE INGENIERÍA DE LA ENERGÍA DEL CAMPUS MARE NOSTRUM



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Quinta edición del Encuentro orientado a servir de espacio de reunión para tratar las distintas facetas de las aplicaciones de la Energía en los ámbitos académico y profesional, así como de instituciones y empresas en el que compartir trabajos, se muestren avances creando un espacio virtual de debate y reflexión en el que plantear soluciones a los importantes retos que la Sociedad tiene en el ámbito de la Energía, englobado en el ODS-7, *Energía asequible y no contaminante*, desde una vocación tecnológica pero a la vez con sensibilidad social.





## NUMERICAL INVESTIGATION OF FERROFLUID FLOW IN EVACUATED TUBE SOLAR COLLECTOR MANIFOLD UNDER THE EFFECT OF EXTERNAL MAGNETIC FIELD

Abderraouf Dahmani <sup>(1\*)</sup>; Juan Pedro Solano Fernández; Samir Laouedj

### RESUMEN

In the present contribution, a new technique for heat transfer enhancement has been used in evacuated tube solar collector (ETSC), it is based on the application of an external magnetic field on ETSC's manifold during the flow of ferrofluido ( $Fe_3O_4$ /Therminol 66) as a working fluid for the collector.

The investigation has been carried out using an implemented User Defined Function (UDF) programed by the C language, using the commercial CFD code ANSYS Fluent. This UDF includes the magnetic proprieties of the used ferrofluid and numerical model of body force (Kelvin force) which is involved in such interaction between the magnetic field and ferrofluids.

The used model was simplified in order to reduce the complexity of the interaction of three phenomena; hydrodynamic phenomena, the heat transfer and electromagnetism.

The obtained results reveal the effect of the applied magnetic field on the temperature distribution, velocity contours and the flow's streamlines.

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Indica con una X en qué Área temática quieres que sea incluido tu resumen (si el trabajo se puede encuadrar en varias líneas, elegir una.):

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y transformación de la energía  Gestión y control de la energía  Impacto ambiental de la  
energía  Ingeniería de sistemas y equipos energéticos  Máquinas térmicas y de fluidos  
 Movilidad sostenible  Problemática social de la energía  Transferencia de calor y masa

# **NUMERICAL INVESTIGATION OF FERROFLUID FLOW IN EVACUATED TUBE SOLAR COLLECTOR MANIFOLD UNDER THE EFFECT OF EXTERNAL MAGNETIC FIELD**



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# Introduction

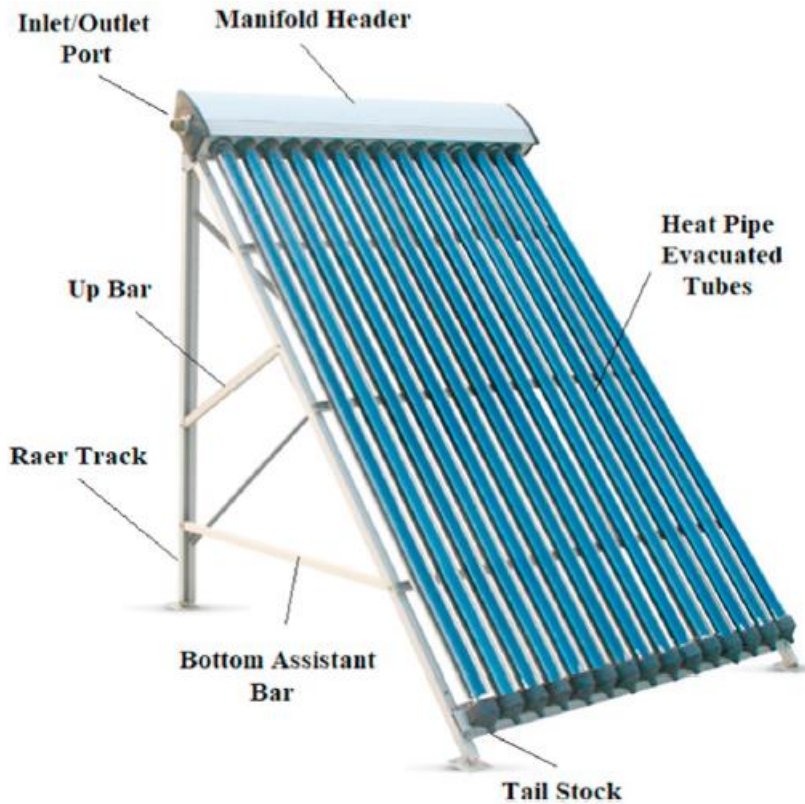


Figure 1– Evacuated tube solar collector

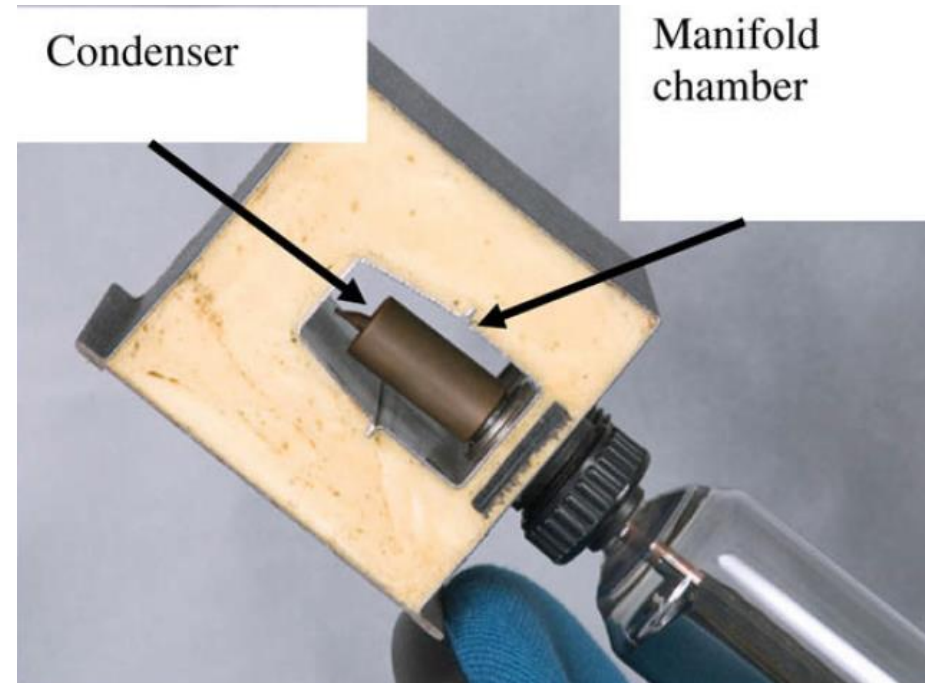


Figure 2– Heat pipe condenser [1]

# Introduction

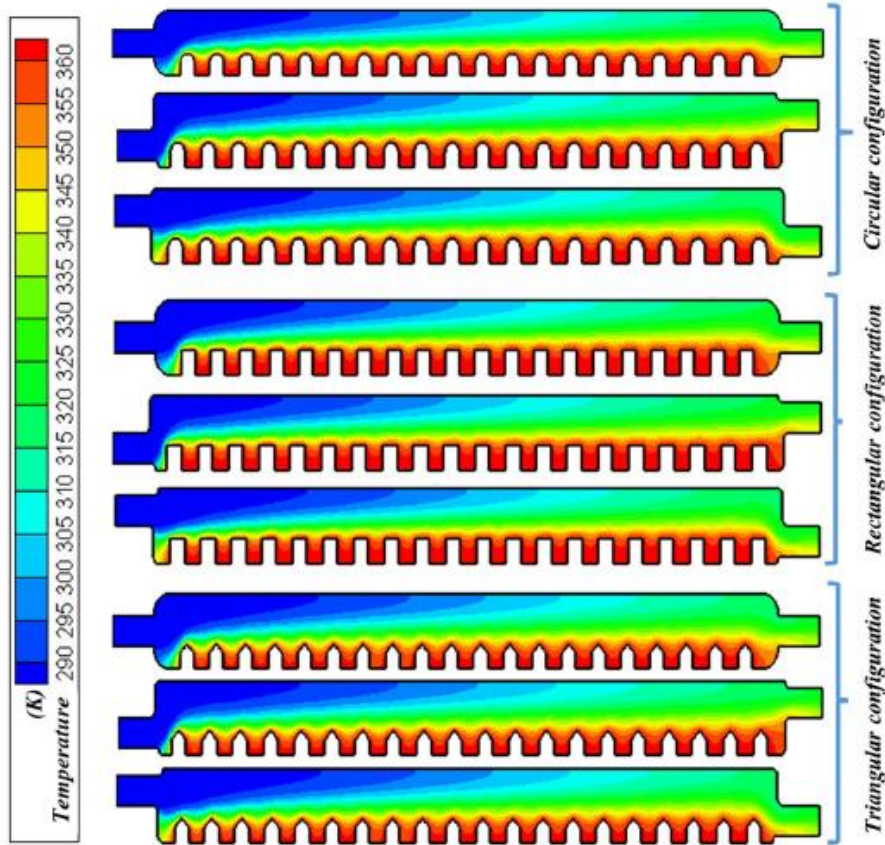


Figure 3

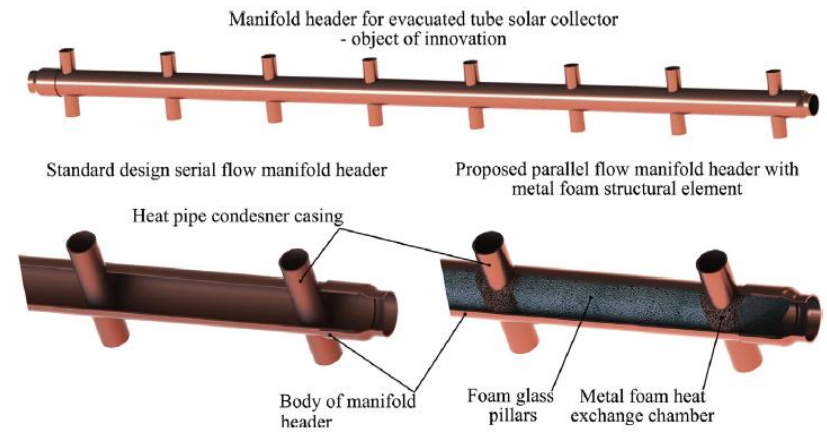
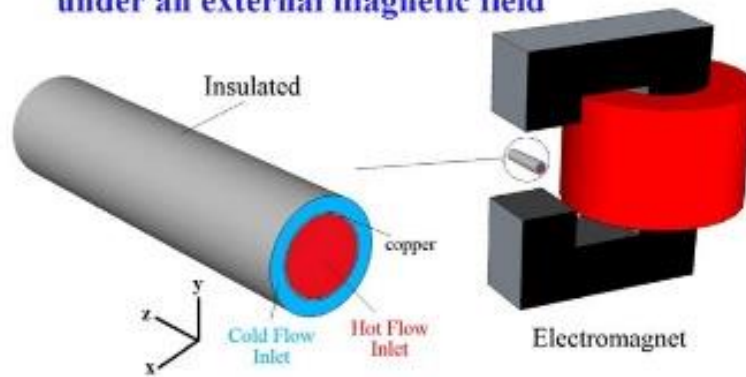


Figure 4

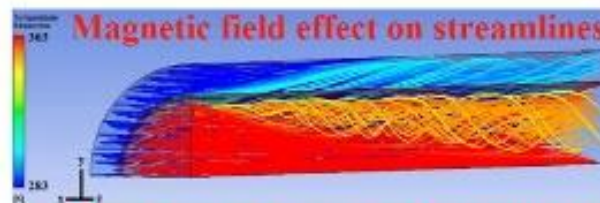
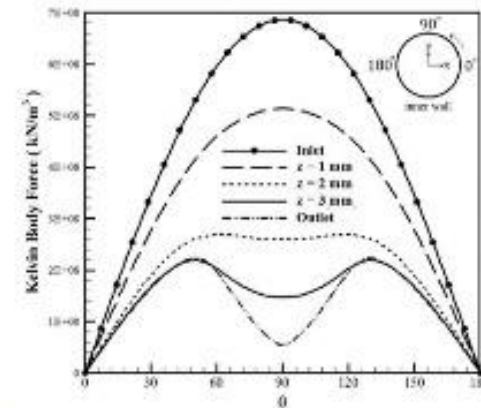
# Introduction



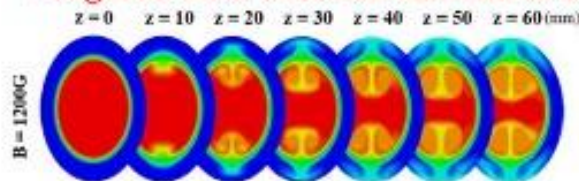
## Ferrofluid flow in a mini heat exchanger under an external magnetic field



## Resulting magnetic force



## Magnetic field effect on thermal b. l.



## Heat transfer enhancement

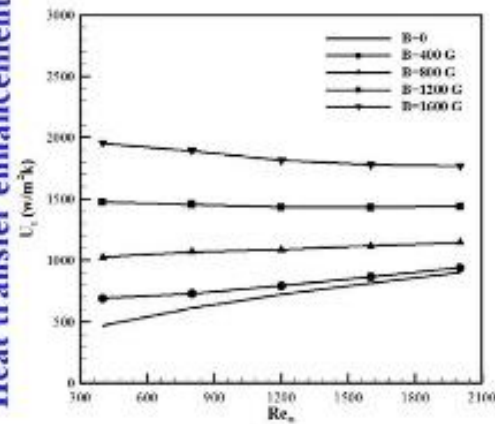


Figure 6- [4]

# Introduction

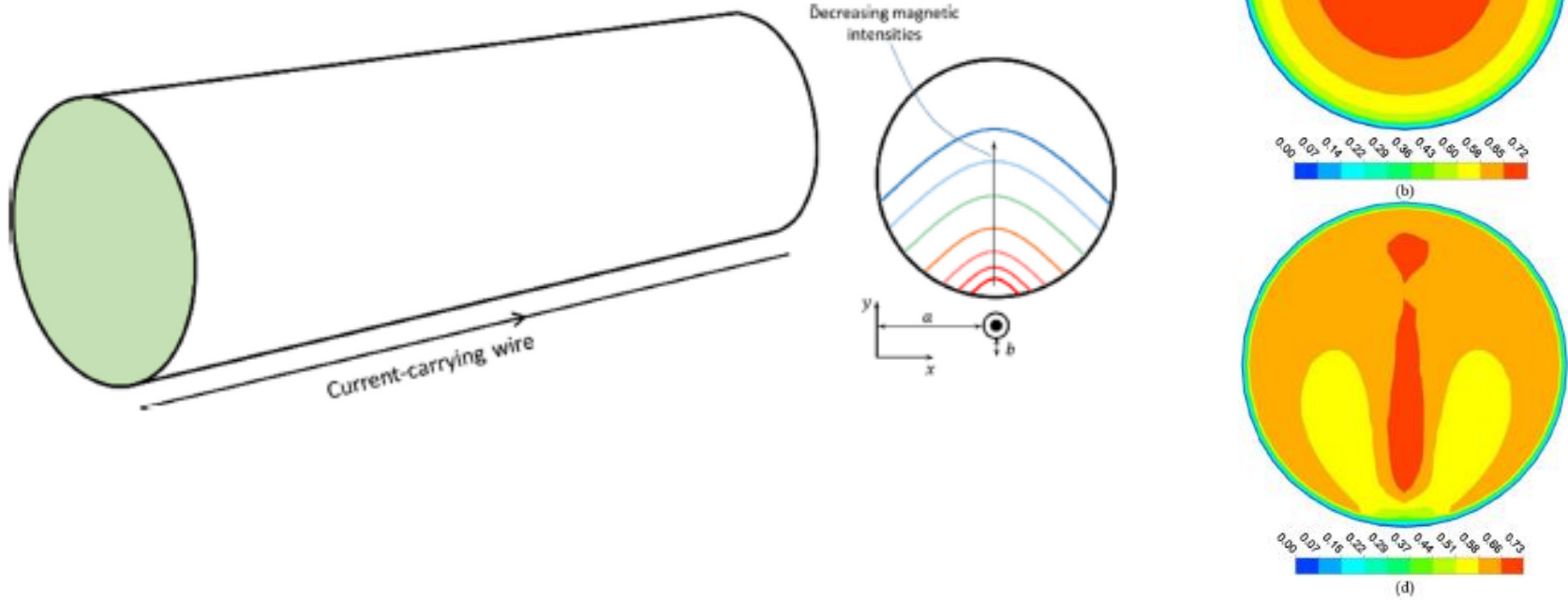


Figure 5- [3]

# Methodology

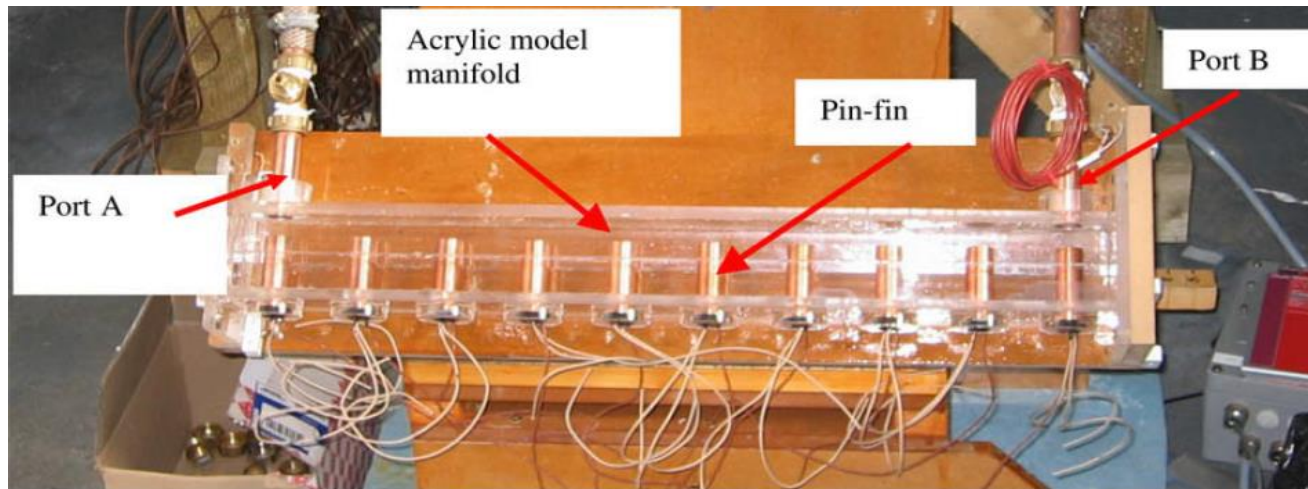


Figure 5 – Acrylic model manifold []

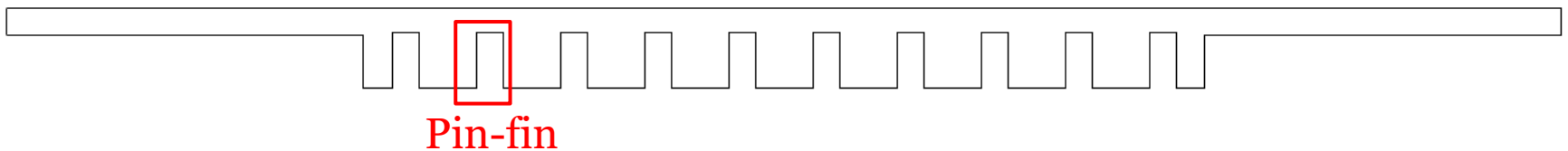


Figure 6 – 2D Schimatic model of manifold

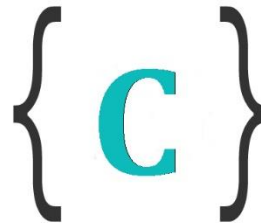


# Mathematical model



Kelvin body force [2]

$$F_k = -\mu_0 \chi_m H^2 \frac{\chi_0 \beta}{[1 + \beta(T - T_0)]^2} \frac{\partial T}{\partial y} \vec{j} = -\mu_0 H^2 \frac{\chi_0^2 \beta}{[1 + \beta(T - T_0)]^3} \frac{\partial T}{\partial y} \vec{j}$$



PROGRAMMING



# Methodology

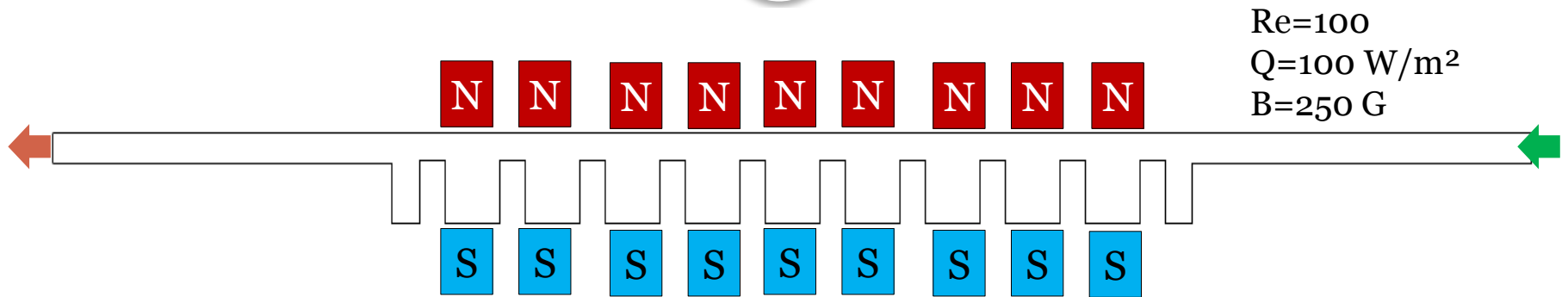


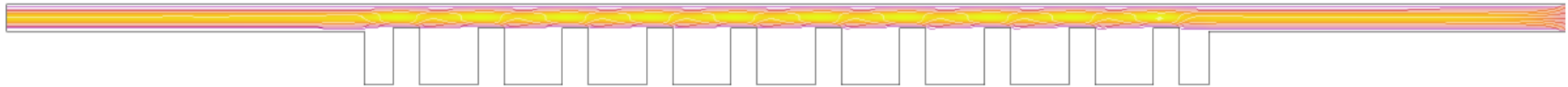
Figure 7 – Manifold 2D model



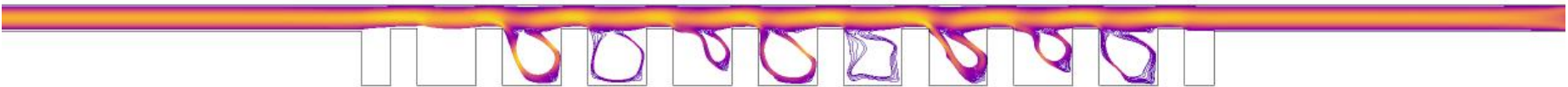
# Streamlines



$B=0$  G



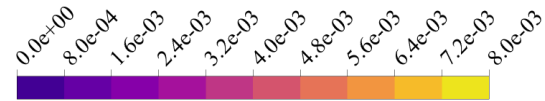
$B=250$  G



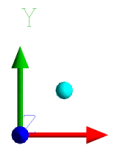
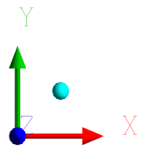
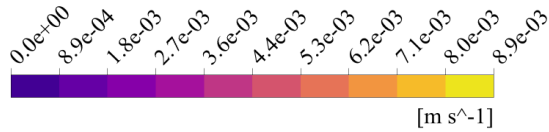
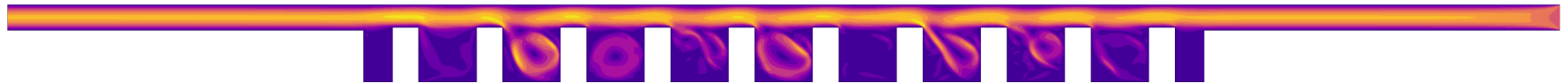
# Velocity contours



B=0 G



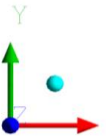
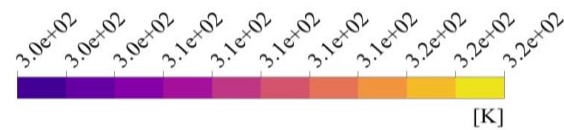
B=250 G [m s<sup>-1</sup>]



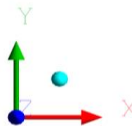
# Temperature distribution



B=0 G



B=250 G



# Conclusion



- The present contribution is a preliminary idea

Using the ferrofluids as working fluid could be promoting and innovative due to its behavior in the presence of an external magnetic field .

## **Future works :**

- Validation of the numerical model for magnetic force (Kelvin force) on previous works or experimental results
- Investigate numerically a 3D model cases (different magnetic field intensities and configurations )

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**Thank you for your  
attention!**

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