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ANALYSIS OF RATE OF INCREASING HEAT TRANSFER IN A COMPOSITE MATERIAL ON MICRO TUBES USING CFD

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ABSTRACT: The Micro tube (MT) with 0.01 cm diameter and 20 cm length is utilizing in this investigation. This investigation covers Reynolds number in the variety of 90 to 800.CFD evaluation to investigate the heat transfer coefficient, heat transfer rate, pressure drop and mass flow rate at exceptional NANO fluids MgO and TiC at unique quantity fractions 0.4 & 0.5.

Thermal evaluation to verify the temperature distribution and heat flux with specific substances. Generally for micro tube is made of copper which is replaced with composite materials.

I. INTRODUCTION TO MICRO TUBE

The use of micro tubes allows Mezzo to offer highly competitive performance on many types of heat exchangers, including radiators, intercoolers, oil coolers, and even industrial shell and tube heat exchangers.DNA shearing with Covaris AFA and micro tube is used by the leading sequencing centers worldwide. The micro tube is also ideally suited for other applications with AFA in small volumes such as Chromatin Shearing for ChIP, Tissue disruption and homogenization for biomarker discovery and ADME/Tox screening.

The Covaris micro TUBE is specifically designed and engineered for compatibility with Focused-ultra sonicators utilizing AFA technology and small sample volumes. The micro TUBE is widely used to shear DNA and RNA into fragments with distributions centered from 100 to 1,500 bp (for larger size DNA see our mini TUBE and g-TUBE products). DNA Shearing with AFA and micro TUBE is the industry standard and the recommended method for DNA shearing by Illumina, Life Technologies, and Agilent. DNA shearing with Covaris AFA and micro TUBE is used by the leading sequencing centers worldwide.

The micro TUBE is also ideally suited for other applications with AFA in small volumes such as Chromatin Shearing for ChIP, Tissue disruption and homogenization for biomarker discovery and ADME/Tox screening.

The micro TUBE is a critical component of the AFA acoustic circuit, focusing the acoustic energy and optimizing inertial cavitations. Micros TUBE are made of a special borosilicate glass for low impedance and better transmission of acoustic energy. The integrated AFA fiber helps nucleation of cavitation bubbles and allows more uniform sample processing, which in turn increases the efficiency and reproducibility of nucleic acid shearing. The result is the simultaneous collapse of millions of high energy bubbles that allow Covaris microtube to accurately, precisely, and controllably exert mechanical energy on your sample. This energy is able to shear DNA and RNA down to 100 bp one magnitude faster than other technologies. Focused-ultra sonicators utilizing AFA technology is also used extensively to shear chromatin and disrupt tissues.

II. LITERATURE SURVEY

The heat exchanger is major element as far as heat transfer and energy conservation is concern. There are so many types of heat exchangers available but due to wide range of design possibilities, simple manufacturing, low maintenance cost, cross flow and counter flow heat exchanger extensively used in petroleum, petrochemical , air conditioning, food storage and other industries. The shell and tube heat exchanger is widely used in industries as a chiller plant for transfer waste heat from the injection molding machine to the cooling water for improve the efficiency of the injection molding machine. The transformations of the waste heat from the injection molding machine to the cooling water are dependent

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on the heat exchange capacity of heat exchangers. To increase the heat exchange capacity of heat exchanger optimization is done which seeks to identify the best parameter combination of heat exchangers. The prefix parameter (tube diameter) is used as an input variable and the output parameter is the maximum temperature difference of shell and tube heat exchanger. Nine models are made on the basis of taguchi method in NX 10.00 and CFX analysis is carried out in ANSYS 14.5. Result obtained from that gives the best dimension of heat exchanger for minimum outlet temperature of water.

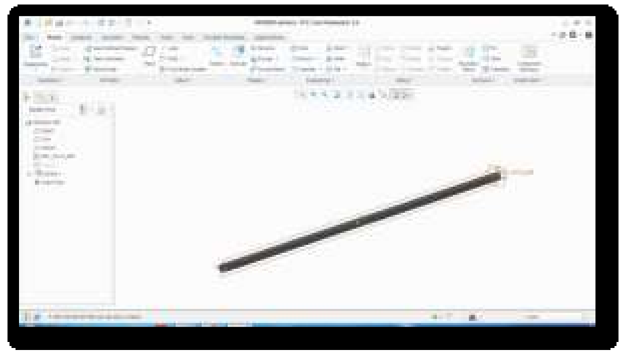
III. INTRODUCTION TO CAD

Computer-aided design (CAD) is that the use of pc systems (or workstations) to help within the creation, modification, analysis, or improvement of a style. CAD package is employed to extend the productivity of the designer, improve the standard of style, improve communications through documentation, and to form an info for producing. CAD output is usually within the type of electronic files for print, machining, or alternative producing operations. The term CADD (for pc assisted style and Drafting) is additionally used.

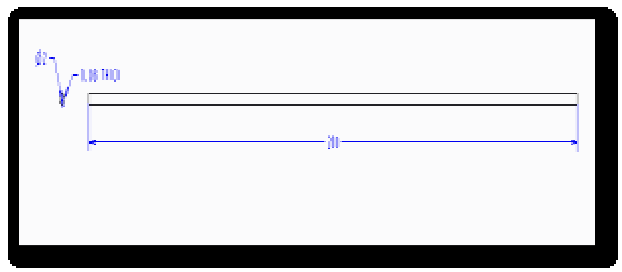
INTRODUCTION TO CREO

PTC CREO, earliest called Pro/ENGINEER, is 3D modeling package utilized in engineering science, design, producing, and in CAD drafting service companies. It had been one among the primary 3D CAD modeling applications that used a rule-based constant quantity system. Parameters, dimensions and options to capture the behavior of the merchandise, it will optimize the event product in addition because the style itself.

3D MODEL OF MICRO TUBE



2d model of micro tube



INTRODUCTION TO FEA

Finite Element Analysis may be a technique of finding, sometimes roughly, sure issues in engineering and science. It's used primarily for issues that no precise resolution is required. Mainly used in some mathematical modeling of a structure or member in design or thermal analysis. Strategies of this kind area unit required as a result of analytical strategies, sophisticated issue that are used in engineering. For instance, in engineering strength of materials or the mathematical theory of snap are often want to calculate analytically the stresses and strains during a bent beam.

ANSYS Mechanical

ANSYS Mechanical may be a finite part analysis tool for structural analysis, as well as linear, nonlinear and dynamic studies. This framework product provides finite parts to model behavior, and supports material models and equation solvers for a good vary of

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mechanical style issues. ANSYS Mechanical conjointly includes thermal analysis and coupled-physics capabilities involving acoustics, electricity, thermal–structural and thermo-electric analysis.

Fluid Dynamics

ANSYS Fluent, CFD, CFX, FENSAP-ICE and connected package area unit procedure Fluid Dynamics package tools employed by engineers for style and analysis. These tools will simulate fluid flows during a virtual setting — for instance, the fluid dynamics of ship hulls; turbine engines (including the compressors, combustion chamber, turbines and afterburners); craft aerodynamics; pumps, fans, HVAC systems, combining vessels, hydro cyclones, vacuum cleaners, etc.

Base fluid properties

Quantity fraction= 0.Four & 0.5(taken from journal paper)

Fabric houses

MAGNESIUM OXIDE

Density = 3560 kg/m3

Thermal conductivity =45 W/m-ok

Designated heat = 955 J/kg-ok

TITANIUM CARBIDE

Density = 4930 kg/m3

Thermal conductivity =330 W/m-k

special warmth = 711 J/kg-k

WATER

Density = 998.2 kg/m3

Thermal conductivity = 0.6 W/m-ok

certain heat = 4182 J/kg-k

Viscosity = 0.001003kg/m-**s**

FORMULAS

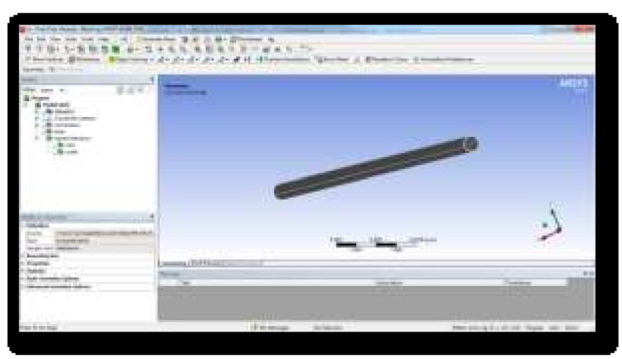
PROPERTIES	FORMULA
DENSITY	$\rho_{mix} = \phi \times \rho_{R160} + [(1-\phi) \times \rho_{R30}]$
SPECIFIC HEAT	$C_{pmix} = \frac{\phi \times \rho R160 \times CpR160 + (1-\phi)(\rho R30 \times CpR30)}{\phi \times \rho R160 + (1-\phi) \times \rho R30}$
THERMAL CONDUCTIVITY	$K_{mix} = \frac{K1+2K2+2(K1-K2)(1+\beta)^3 \times \phi}{K1+2K2-(K1-K2)(1+\beta)^3 \times \phi} \times k_2$
VISCOSITY	$\mu_{mix} = \mu_{R160} (1+2.5\phi)$

Calculations

FLUID PROPERTIES

FLUID	Volume fraction	Thermal conductivity (w/m-k)	Specific heat (J/kg-k)	Density (kg/m³)	Viscosity (kg/m-s)
MAGNESIUM OXIDE	0.4	0.184577	1910.408	2022.92	0.002006
	0.5	0.20283	1900.404	2025.94	0.002256
TITANIUM CARBIDE	0.4	2.625	5357.01	2570.92	0.002006
	0.5	4.12	4069.1	2964.1	0.002256

IMPORTED MODEL



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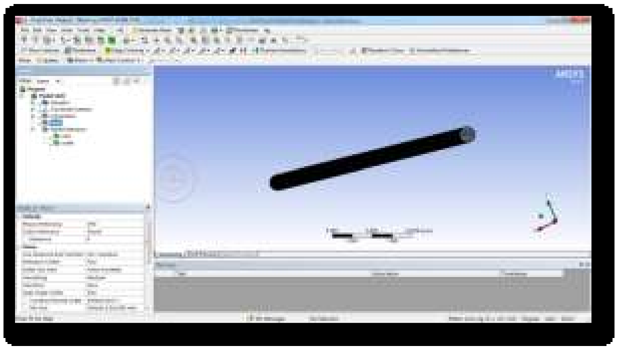
MESHED MODEL



No ‘of nodes and elements

Statistics	
Nodes	147120
Elements	120099

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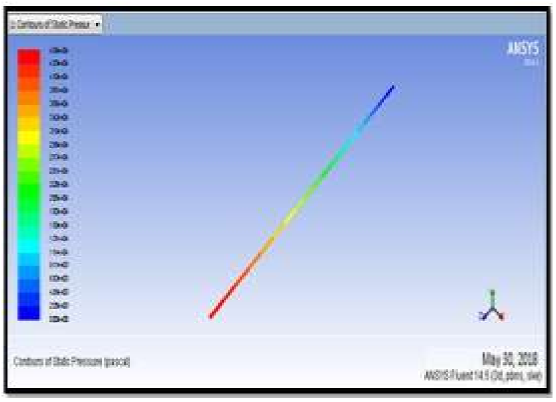
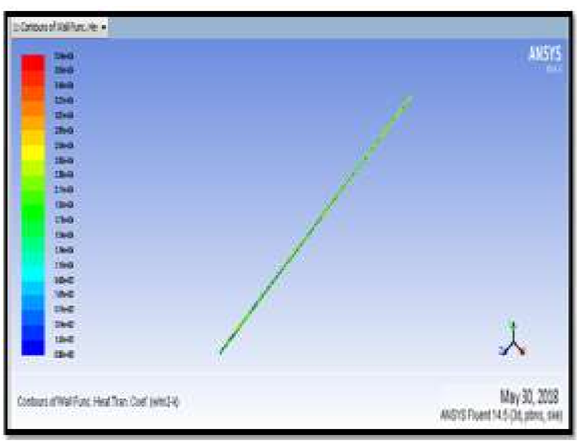
Fluid -TiC

Re-500

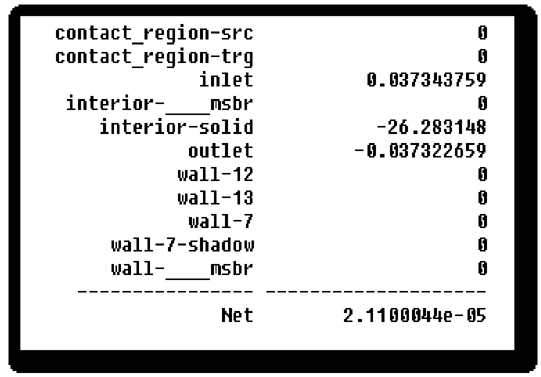
PRESSURE



HEAT TRANSFER COEFFICIENT

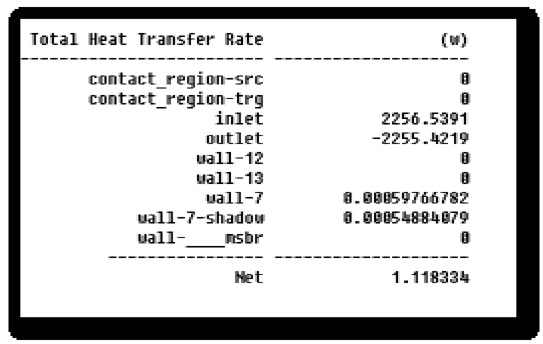


MASS FLOW RATE



contact_region-src	0
contact_region-trg	0
inlet	0.037343759
interior-____msbr	0
interior-solid	-26.283148
outlet	-0.037322659
wall-12	0
wall-13	0
wall-7	0
wall-7-shadow	0
wall-____msbr	0
Net	2.1100044e-05

HEAT TRANSFER RATE

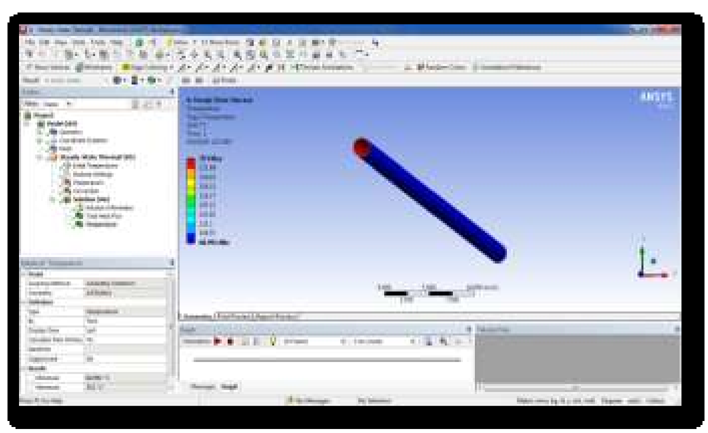


Total Heat Transfer Rate	(w)
contact_region-src	0
contact_region-trg	0
inlet	2256.5391
outlet	-2255.4219
wall-12	0
wall-13	0
wall-7	0.00059766782
wall-7-shadow	0.00054884079
wall-____msbr	0
Net	1.118334

THERMAL ANALYSIS OF MICRO TUBE

Material- PMMA Matrix

Temperature distribution



Heat flux

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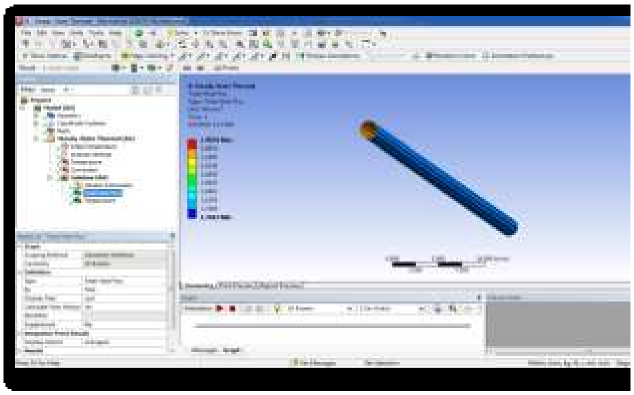

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RESULT TABLE: Analytical Investigation

Cfd analysis results

Nano fluid	Volume fraction (Φ)	Reynolds number	Pressure (Pa)	Heat transfer coefficient (w/m2-k)	Mass flow rate(kg/s)	Heat transfer rate(W)
MgO	0.4	100	1.03e+04	1.72e+03	3.764e-06	0.09290
		500	2.23e+04	1.72e+03	1.7955e-06	0.04625
		800	3.95e+04	1.72e+03	2.074e-05	0.56198
	0.5	100	9.30e+03	1.89e+03	2.135e-05	0.591506
		500	2.46e+04	1.89e+03	2.644e-05	0.7025138
		800	4.62e+04	1.89e+03	2.19e-05	0.60643
TiC	0.4	100	8.5e+03	2.45e+04	1.6073e-05	1.3796
		500	2.55e+04	2.45e+04	1.3839e-05	1.0530459
		800	4.52e+04	2.45e+04	1.9699e-05	1.6916
	0.5	100	8.96e+03	3.84e+04	1.1020e-05	0.67324
		500	2.57e+04	3.84e+04	1.505e-05	0.8792
		800	4.56e+04	3.84e+04	2.11e-05	1.118334

Thermal analysis results

Material	Temperature (°C)		Heat flux (w/mm²)
	Max.	Min.	
Copper	353	352.97	0.14008
Carbon epoxy	353	352.98	0.14009
E-glass epoxy	353	352.96	0.1401
Pmma –matrix	353	68.991	1.9876

V. CONCLUSION

The Micro tube (MT) with zero.01 cm diameter and 20 cm length is making use of in this investigation. This investigation covers Reynolds quantity in the variety of ninety to 800.

CFD evaluation to decided the warmness transfer coefficient, heat transfer price, pressure drop and mass glide cost at distinctive NANO fluids(MgO and TiC) at special volume fractions zero.4 &zero.5.

Thermal evaluation to decided the temperature distribution and warmth flux with specific substances. Present used fabric for micro tube copper, replaced with composite substances.

By means of gazing the CFD analysis outcome the warmth transfer coefficient raises by using increasing the quantity fraction. Extra warmth transfer coefficient value for titanium carbide at quantity fraction 0.5.

Through staring at the thermal analysis results the heat flux value more for PMMA-Matrix.

VI. REFERENCES

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