DEDICATION

Dedicated to:

My mother

My father

My wife (**Amal**)

My Sons (**Ahmed** & **Mokhtar**)

My family and my **Friends**

With my love and respect

ACKNOWLEDGMENT

Thanks to my supervisor

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ABSTRACT

A Heat Exchanger System has been designed in this research, to be used in an industrial field. The system consists of an industrial unit for chemical process; shell and tube heat exchanger to produce heating fluid and an insulated pipe to transport fluid between them. The required temperature for the product has been taken into consideration through the process of evaluating the necessary calculations for fluid heating and the dimensions and sizes of varied facilities of the system are identified.

An overall heat transfer coefficient has been assumed and compared with its calculated value from the design of shell and tube heat exchanger according to the international standards and codes available. As a result the percentage difference between the assumed and calculated values was found within the allowable range.

A computer program was built, and verified with known data. The results for the designing calculations from the program were acceptable compared to that achieved.

الخلاصة

في هذا البحث تم تصميم منظومة تبادل حراري تستخدم في الحقل الصناعي وتتكون المنظومة من وحدة صناعية للمعالجة الكيميائية ، مبادل حرارى من النوع القشرى وانبوب معزول لنقل مائع التسخين بينهما.

تم مراعاة حفظ المنتج في درجة الحرارة المطلوبة بعمل الحسابات اللازمة لمائع التسخين وتحديد أبعاد وأحجام مواعين النظام المختلفة.

تم افتراض قيمة لمعامل انتقال الحرارة الكلى ومن ثم تمت مقارنه معامل انتقال الحرارة الكلى الذى افترض والناتج من التصميم للمبادل الحرارى القشرى وفق المواصفات العالمية حيث أن النسبة المئوية بين القيمة المفترضة والمحسوبة لا تتعدى القيمة المسموح بها.

تم عمل برنامج حاسوب لتغطية حسابات التصميم وتم اختباره بواسطة قيم حقيقية وكانت مخرجات البرنامج مساويه لتلك القيم التى تم الحصول عليها بواسطة اجراء العمليات الحسابيه.

Table of Contents

List of symbols

Symbols	Means	Unit
A	The heat transfer surface area of the inner cylinder	[m^2]
A_i	Total area of flow in tube side	[m^2]
A_{sh}	Total area of flow in shell side	[m^2]
A_T	Effective heat transfer area in shell and tube heat exchanger	[m^2]
Cp	Specific heat capacity	[J/kg °K]
Cp_c	Specific heat capacity for cold water	[J/kg °K]
Cp_h	Specific heat capacity for hot water	[J/kg °K]
Cp_s	Specific heat capacity of the sulfur	[J/kg °K]
Cp_w	Specific heat capacity of water inside outer cylinder	[J/kg °K]
Cp_{co}	Specific heat capacity of coil water	[J/kg °K]
D	Diameter	[m]
D_i	Inner cylinder diameter	[m]
D_o	Outer cylinder diameter	[m]
d_{co}	Coil tube outer diameter	[m]
d_i	Inner diameter of tube in shell and tube heat exchanger	[m]
d_o	Outer diameter of tube side in shell and tube heat exchanger	[m]
d_{max}	Maximum diameter of helical coil	[m]
d_{min}	Minimum diameter of helical coil	[m]
d_{sh}	Diameter of shell in shell and tube exchanger	[m]
h_i	Heat transfer coefficient inside tube	[W/m°K]
h_o	Heat transfer coefficient outside tube	[W/m°K]
J_f	Frication factor	
K_{ins}	Thermal conductivity of insulation material	[W/m°K]
K_m	Thermal conductivity of cylinder or pipes material	[W/m°K]
k_1	Constant	
L	Length	[m]
L_{co}	Coil length	[m]
L_i	Inner cylinder length	[m]
L_o	Outer cylinder length	[m]

L_{pip}	Length of insulation pipe	[m]
M	Mass	
m_s	Mass of sulfur inside inner cylinder	[kg]
m_w	Mass of water inside outer cylinder	[kg]
N_t	Number of tubes in shell and tube exchanger	
Nu	Nusselt number	
n_1	Constant	
n_{co}	Total number of coil turn	
Pr	Prandtl number	
Pt	Tube pitch	[m]
Pt_{co}	Coil pitch	[m]
Q_{con}	Heat transfer by conduction through inner cylinder thickness	[W]
Q_{loss}	Total heat loss in insulation pipe	[W]
Q_{req}	Heat transfer rate required to heat sulfur	[W]
Q_s	Heat transfer rate gain by sulfur	[W]
Q_w	Heat gain by water inside outer cylinder	[W]
Re	Reynolds number	
r_1	Insulation pipe inner radius	[m]
r_2	Insulation pipe outer radius	[m]
r_3	Radius of pipe and insulation cover combined	[m]
T_{amb}	Ambient temperature	[°C]
T_{Coin}	Inlet temperature of coil water into outer cylinder	[°C]
T_{Coout}	Outlet temperature of coil water into outer cylinder	[°C]
T_{mean}	Mean temperature	[°C]
T_{meanco}	Mean temperature of coil water	[°C]
T_{means}	Mean temperature of sulfur powder	[°C]
T_{req}	Required temperature	[°C]
T_s	Temperature of sulfur inside inner cylinder	[°C]
T_{sin}	Inlet temperature of sulfur into inner cylinder	[°C]
T_w	Temperature of water inside outer cylinder	[°C]
T_{win}	Inlet temperature of water into outer cylinder	[°C]
T_1	Temperature in the beginning of insulation pipe	[°C]
T_2	Temperature in the end of the insulation pipe	[°C]
T	The time required to the process	[second]
U	Overall heat transfer coefficient for Shell and tube exchanger	[W/m°K]

U_{ins}	Overall heat transfer coefficient for insulation pipe	[W/m°K]
u	Velocity	[m/s]
u_{co}	Velocity of water inside coil tube	[m/s]
V	Volume	[m³]
V_{co}	Coil volume	[m³]
V_i	Inner cylinder volume	[m³]
V_p	Total volume of product inside inner cylinder	[m³]
V_s	Sulfur inside inner cylinder total volume	[m³]
V_o	Outer cylinder volume	[m³]
V_W	Water inside outer cylinder total volume	[m³]
X	Inner cylinder thickness	[m]
X_{ins}	Insulation thickness	[m]

Greek Symbol

η_p	Percentage of the product from the total volume inner cylinder	
η_{con}	Efficiency of heat transfer by conduction through inner cylinder thickness	
$\dot{m}$	Mass flow rate of the fluid	[kg/s]
μ	Viscosity of the fluid	[kg/ms]
ρ	Density	[kg/m³]
ρ_c	Density of hot water in tube side heat exchanger	[kg/m³]
ρ_h	Density of hot water in shell side heat exchanger	[kg/m³]
ρ_s	Density of sulfur powder inside inner cylinder	[kg/m³]
ρ_w	Density of water inside outer cylinder	[kg/m³]

Abbreviations

DE	Differential Evaluation
GA	Genetic Algorithms
HE	Heat Exchanger
HED	Heat Exchanger Design
HTFS	Heat Transfer Flow Systems
HTRI	Heat Transfer Research Institute
IU	Industrial Unit
IP	Insulation Pipe
LMTD	LOG-Mean Temperature Difference
SA	Simulated Annealing
STHE	Shell and Tube Heat Exchanger
TEMA	Tube Exchanger Manufactures Association
NTU	Number of Transfer Unit

List of Figures

List of Tables