

DESIGN AND DEVELOPMENT OF AN INNOVATIVE
APPARATUS FOR PRODUCING A SPIRAL CATALYST
SUBSTRATE FOR CATALYTIC CONVERTER

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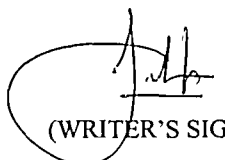


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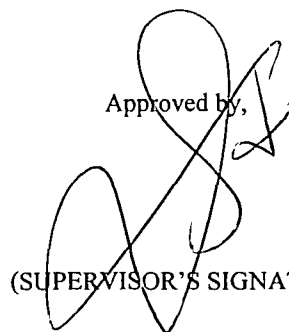


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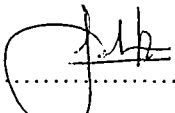
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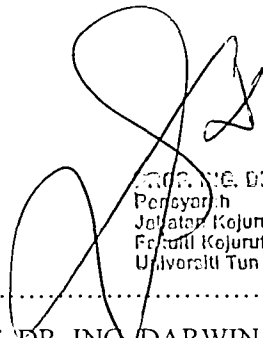
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ABSTRACT

Spiral catalyst substrate is one of the substrate types for catalytic converter and has high geometric surface area. It is to provide support structure in which the washcoat and the catalyst are applied. Currently, an issue of considerable interest in producing the substrate from a thin sheet metal with a thickness 0.11mm and using FeCrAl material has become a trend. Existing patented apparatus overseas use a complicated system and specific details are scarce. Therefore, this research presents the works in designing and developing an innovative apparatus based on a systematic approach of Pahl and Beitz's model of design process. Furthermore, Finite Element Method (Dynaform) was applied for the forming analysis of a trapezoid cell of corrugation on a thin sheet metal and spiral shape of corrugated sheet metal. These works provide the conceptual designs for the apparatus of Corrugated Tool for corrugation process and Spiral Tool for spiral process. The selected conceptual design was established by developing a model of the apparatus. A rule of thumb for requiring unloaded diameter of corrugated sheet metal in spiral shape was derived. Forming Limit Diagram (FLD) shows that the thin sheet metal was successfully formed without any cracking and Thickness Diagram shows that the thickness of the formed thin sheet metal was in safe thickness. The springback effect that occurs during the sheet metal in spiral shape was solved using the developed casing. The designed apparatus of Corrugated Tool and Spiral Tool were fabricated and optimization was performed by producing the spiral catalyst substrate. The innovative apparatus for producing the full scale of spiral catalyst substrate were successfully designed and developed.

ABSTRAK

Spiral catalyst substrate adalah salah satu daripada jenis-jenis *substrate* yang digunakan untuk *catalytic converter* dan mempunyai luas permukaan geometri yang tinggi. Ianya adalah untuk memberi struktur sokongan dimana *washcoat* dan *catalyst* akan ditempatkan. Pada masa ini, isu-isu yang mendapat perhatian dalam membuat *substrate* daripada kepingan logam nipis dengan ketebalan 0.11mm dan menggunakan bahan FeCrAl telah menjadi kebiasaan. Beberapa alatan sedia ada yang telah dipatenkan di luar negara menggunakan sistem yang berselirat dan perincian tidak diberikan sepenuhnya. Oleh itu, penyelidikan ini mempersembahkan tugas dalam merekabentuk dan membangunkan alatan yang inovatif berdasarkan pendekatan yang sistematik model *Pahl dan Beitz's* untuk proses merekabentuk. Tambahan pula, Kaedah Unsur Tidak Terhingga (Dynaform) telah digunapakai untuk analisis pembentukan alunan sel berbentuk trapezoid pada kepingan logam nipis dan bentuk lingkaran kepingan logam yang telah dialunkan. Kerja-kerja ini memberikan gambaran untuk konsep rekabentuk untuk alatan *Corrugated Tool* untuk proses alunan dan *Spiral Tool* untuk proses lingkaran. Konsep rekabentuk yang telah dipilih dimulakan dengan membangunkan model alatan tersebut. *Rule of thumb* untuk mendapatkan diameter tanpa beban kepingan logam yang telah dialunkan dalam bentuk lingkaran telah diperolehi. Rajah Pembentukan Tidak Terbatas (FLD) menunjukkan bahawa kepingan logam nipis telah berjaya dibentuk tanpa sebarang koyak dan Rajah Ketebalan menunjukkan bahawa ketebalan kepingan logam yang dibentuk adalah dalam keadaan selamat. Kesan *springback* yang berlaku semasa kepingan logam dalam bentuk lingkaran telah diselesaikan dengan meletakkan *spiral catalyst substrate* dalam bekas yang dibuat. Alatan yang telah direkabentuk iaitu *Corrugated Tool* dan *Spiral Tool* dibangunkan dan kesempurnaan telah dijalankan dengan menghasilkan *spiral catalyst substrate*.

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LIST OF SYMBOLS

CO	-	Carbon Monoxide
HC	=	Hydrocarbon
NO _x	-	Nitrogen Oxide
D	=	Diameter or Die opening
L	-	Length
cpsi	=	centre per square inch
t	-	Thickness
N _{tu}	=	Effective of mass exchanger
g_{ml}^{oa}	-	Overall mass transfer
\dot{m}_G	-	Mass flow rate of the stream
A _o	-	Cross-sectional area
F	=	Force
σ	-	Tension or stress
e	=	Elongation or nominal strain
l	-	Instantaneous
l _o	=	Original gauge length
E	-	Modulus of elasticity
K	=	Strength coefficient
ϵ	-	Strain
n	=	Exponent coefficient
T	-	Torque
τ	=	Torsion
r	-	Radius
G	=	Shear modulus
K _{bf}	-	Friction
TS	=	Tensile strength

w	-	Width
R_i	-	Initial radius
R_f	-	Final radius
K_s	-	Springback factor
Y	-	Yield stress
FLD	-	Forming Limit Diagram
θ	-	Angle
F_t	=	Angular force
F_r	-	Radial force
P	=	Power
HP	-	Horsepower