Optimizing In Forging Process Production with Product Development in Hot Forging Process by Development of New Operation designed.

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***Abstract*— That research gets optimizing production in the hot forging process by adding one new operation in the forging process. forging process various types of defects are carried in regular manufacturing processes such as bending, twisting miss matching, underfill, etc. so in that Paper we consider some process defects which are carrying some critical products such as connecting rods, suspension arm such, and uneven surfaces. Such products have some important parameters considered in the machining and coning process, bending and twisting. Such defects effects on coning die and process and machine tool. In that paper reducing such defects by using some process development with adding additional operations before trimming or after blocking such as hot padding.**

***Index Terms*— Hot padding operation, Die of padding. Bending and Twisting**

Introduction

Manufacturing process in forging

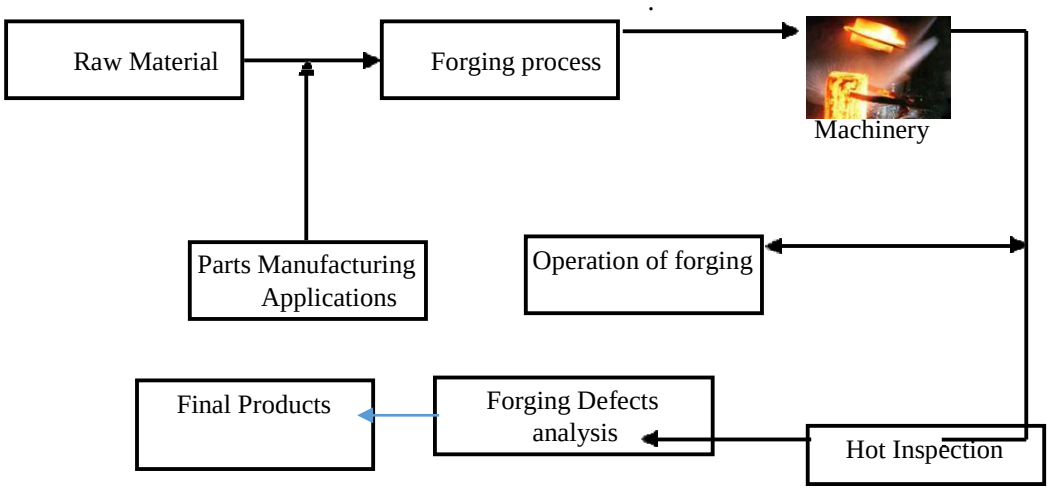


Figure -1. Manufacturing Process of Plant at initial level

Figure 1 Forging is the process by which metal is heated and is shaped by plastic deformation by suitably applying compressive force. Usually the compressive force is in form of hammer blows using a power hammer or a press. Forging process commonly used in industry and affected by process defects that occur in a forging industry that causes high rejection rate in the components. The five significant parameters such as billet weight, billet length, billet temperature, forging time, and the die temperature were used to optimize and reduce the rejection due to various forging defects. The defects in the forged components includes the lapping, mismatch, scales, quench crack, under filling etc.

The research focus on forging in process defects controlling such as surface defects, Inspection defects, process wastage which in from by flash formation. Focus on improvement of die life by regular corrective action, process defects bending. ”

I Surface defects- 1) Burr lap (Operation defects)
2) Scale Pit (Manual defects)
3) Under Fill (Location, Operation defects)
4) Dent Mark (Manual defects)
5) Punch Mark (Location or misalignment of die)
6) Under Cut (Trimming defects)

II Inspection defects- 1) Mismatch (Die shifting)
2) Size Variation (Temperature variation)
3) Bend (Operation defects)
4) Crack (Overheating and force)

III Process wastage- 1) Cutting operation (End piece)
2) Flash wastage (After Trimming)

METHODOLOGY

Step -I

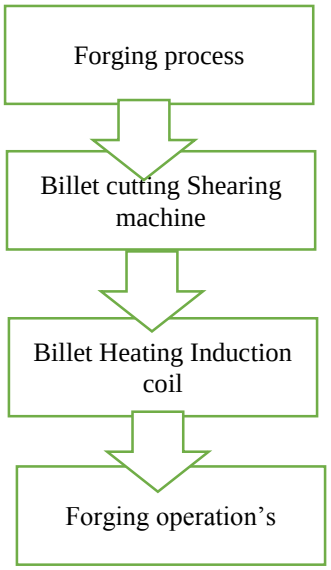


Fig.02 initial process in forging operation

VARAD FORGE PVT. LTD. ENGINEERING

Sr. No.	Date	Material grade	Heat No	Heat Code	Dia. Φ	Bar Length mm	Total Bar weight KG	Total Bar Qty.
1	7/5/2016	41CR4	2-NTY-4	IQ	60Φ	5412 MM	10790	91
2	7/19/2016	EN8D	M54543	B4.1	60Φ	5621 MM	8499	70
3	7/19/2016	C70S6	K101909	AS	56Φ	4560 MM	18555	170
4	7/25/2016	41CR4	WIQ	IS	60Φ	4712 MM	10900	98
5	7/31/2016	C70S6	KO97498	AT	56Φ	5540MM	16060	140
6	8/5/2016	16MNCR5H	K12789	D8.1	60Φ	5416MM	17180	134
7	8/5/2016	C70S6	K102795	AU	56Φ	5622MM	21760	186
8	8/5/2016	42CRMO4	K102473	FB5	75Φ	5413 MM	19980	97
9	8/8/2016	16MNCR5H	M10586	C8.1	75Φ	5416MM	23305	128

10	8/9/2016	C70S6	K102795	AV	56Φ	5590MM	22900	195
11	8/20/2016	C70S6	K103222	AW	56Φ	5612 MM	25900	220
12	8/21/2016	16MNCR5H	M102998	G7.1	60Φ	5516 mm	15820	124
13	8/21/2016	SAE1541	23494	AA	60Φ	5792 MM	1950	15
14	8/22/2016	41CR4	OEM	JE	60Φ	5412 MM	10580	80
15	8/29/2016	C70S6	K103222/102820	AW	56Φ	4616 MM	25710	230
16	9/3/2016	16MNCR5H	M103692	D9.1	60Φ	4718 MM	20675	163
17	9/4/2016	C70S6	M102820	AX	56Φ	5412MM	25300	240

Table 01 - Shearing machine record.

Step one initial process induction coil selection dependent on raw material diameter and length of cut pieces. That all are initial process which are identification of material and heating process carry in forging process information showing above table . Heating code martial grade heat number and diameter of bar and billet size. Which are importance for next operation of forging process.

Step II-

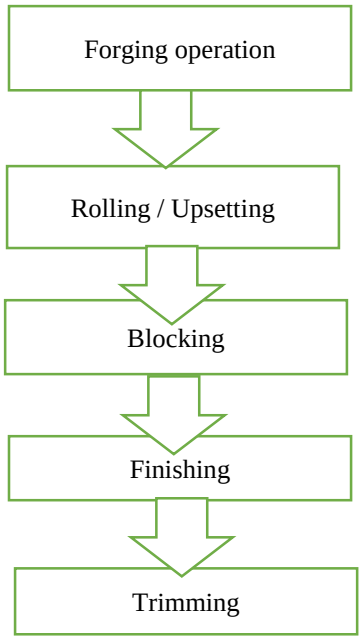


Fig03 General Process In Forging

In forging process drawing operation are carry by rolling operation having basically classified by path on that rolling mills. Basically forging process two, three, four, rolling path operation done. Forging job length are depends on rolling operation. Gap between two rolling mills is the one of important parameter in rolling mills. Upsetting is one of material gather operation in which material flow is done are required shape and size of job. Blocking is one of important operation in which semi fishing work is done by billet material and providing basic shape of job before finishing operation. Finishing are final operation in forging process after that trimming operation performed in which flash get trimmed out. .

Step –III

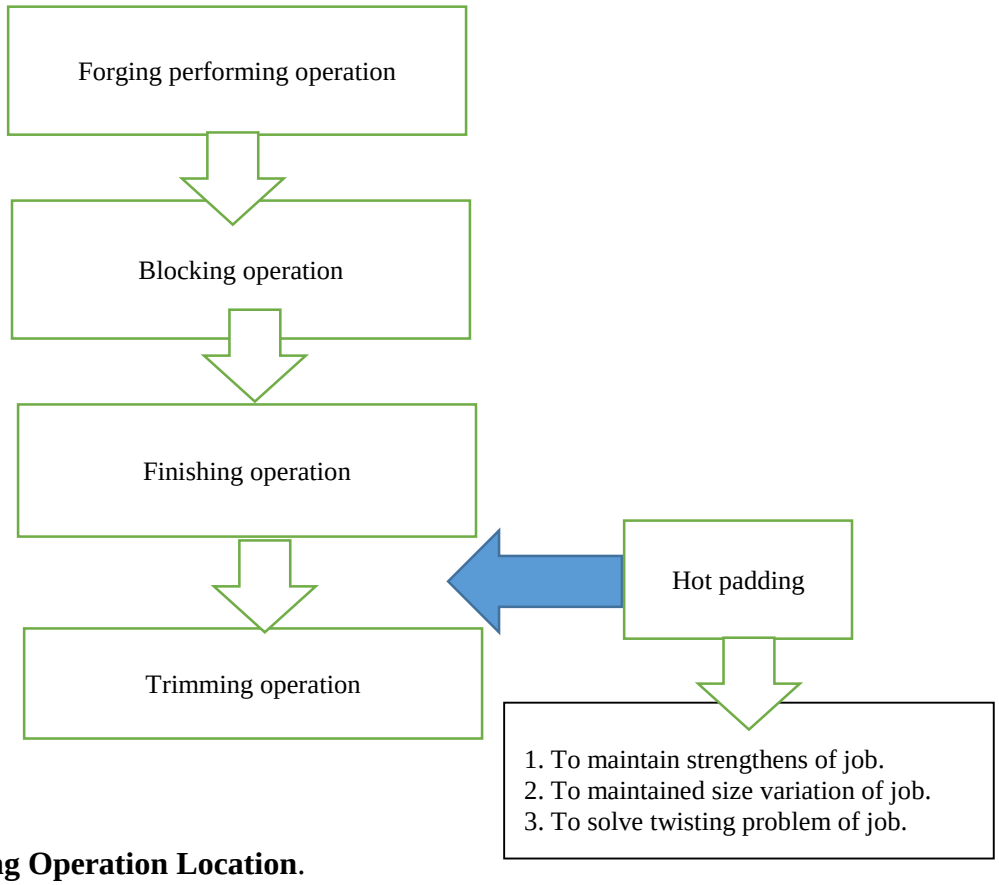


Fig.04 Hot Padding Operation Location.

Product analyses by temperature

In that research paper we consider two product such as connecting rod and suspension arm. Details analyses done by connecting rod products as below. First record the temperature of product by initial to final product. Record temperature of product by stroboscope measurement device which are indirect measurement process.

1. Temperature measurement -1. Forging process temperature
   2- Trimming process
   3. After trimming conveyer temperature.
   4. Conveyer Exit temperature.

PART NAME : CON ROD	**Control Cooling**	DATE :-
PART NO : LML-TDG-P3-03		2/16/2016
CUSTOMER : LOKESH Mc		
VFPL DRG NO. : D106-01		

Temperature Measurement (°C)

Hardness:- 280-285BHN

Sr.No.	IBH	Trimming Entry	Conv.Entry	Conv.Exit.	Remarks
1	1182	1066	739	487	
2	1185	998	850	433	
3	1178	1016	762	506	
4	1173	947	826	475	
5	1173	990	727	486	
6	1170	1034	900	494	
7	1174	1004	784	500	
8	1168	989	853	497	
9	1200	1013	722	494	
10	1190	1058	811	483	
Range	**1100-1150**	**900-1050**	**810-900**	**500-620**	

Table – 02 Temperature measurement

Product analyses by measurement

Product analyses done with the help of connecting rod products. Such product get measurement by two different methods such as after trim component measurement and before trim component measurement. So that after that measurement analyses done by job size variation by both conditions. Three importance parameter's consider Samll end, I –section and Big end of connecting rod.

PART NAME : CONNECTING ROD
DATE : 14/04/2020
PART NO : LML-TDG-P3-03
CUSTOMER : LOKESH MACHINE LTD.
VFPL DRG NO. : D106
Thickness Measurement

Trim Component

Section	Samll End				I-Section			Big End				
Sr.No.	1	2	3	4	1	2	3	1	2	3	4	Remarks
1	38.9	39.1	39.1	38.9	19.4	19.2	19.5	39	39.1	39	39.3	
2	38.5	38.8	39.0	38.8	19.3	19.4	19.6	38.8	39	38.9	39.1	
3	39.2	39.4	39.6	39.1	20.2	20.1	20.4	39.9	39.7	39.6	39.8	
4	38.8	39.0	39.0	38.8	19.5	19.5	19.5	38.8	38.9	38.7	39.2	
5	38.8	38.8	38.8	38.8	19.1	19.0	19.2	38.8	38.8	39	39	
6	38.8	38.9	39.1	38.8	19.4	19.2	19.4	38.9	39.1	38.9	39.2	
7	38.8	38.9	39.2	38.8	19.5	19.5	19.5	39.2	39.1	39	39.3	
8	38.8	39.0	39.1	39.9	19.4	19.3	19.5	39.1	39	39	39.2	
9	39.3	39.3	39.4	39.2	19.5	19.4	19.4	39.3	39.2	39.1	39.4	
10	38.8	38.7	39	38.8	19.3	19.1	19.4	38.9	39	38.8	39.1	

Untrim Component

Section	Samll End				I-Section			Big End				
Sr.No.	1	2	3	4	1	2	3	1	2	3	4	Remarks
1	39.6	39.9	39.7		19.9	19.9	19.9	39.8	39.4	39.7		
2	39.6	39.6	39.6		20.1	20.1		39.9	40.0	39.7		
3	39.7	39.8	39.8		19.8	20.0	20.1	39.3	39.8	39.6		
4	39.4	39.2			19.7			39.4	39.6			
7												

Table 03.Analyses of Connecting Rod after Trimming

Small end measurement in that we observed that thickness of job get varied in 38.5mm to 39.6mm with their basic size. Variation are found ±0.5mm approximate. Which indicating by bellow graphical presentation.

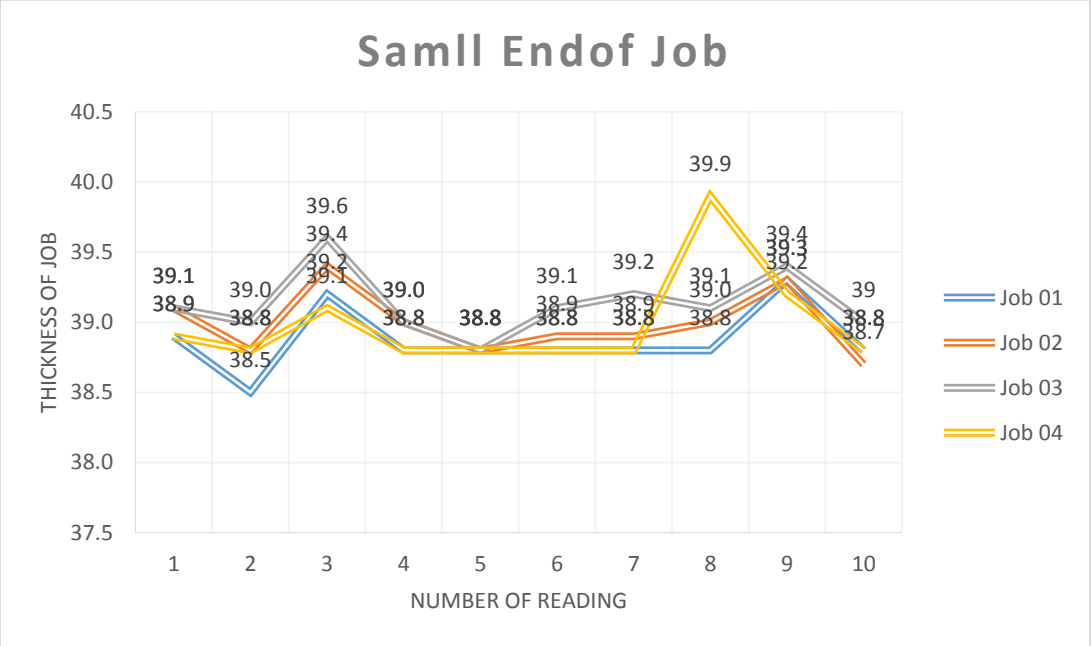


Fig.05 Samll End Measurement

Big end measurement in that we observed that thickness of job get varied in 38.7mm to 39.9mm with their basic size. Variation are found +0.9mm and $-0.5mm$ approximate. Which indicating by bellow graphical presentation.

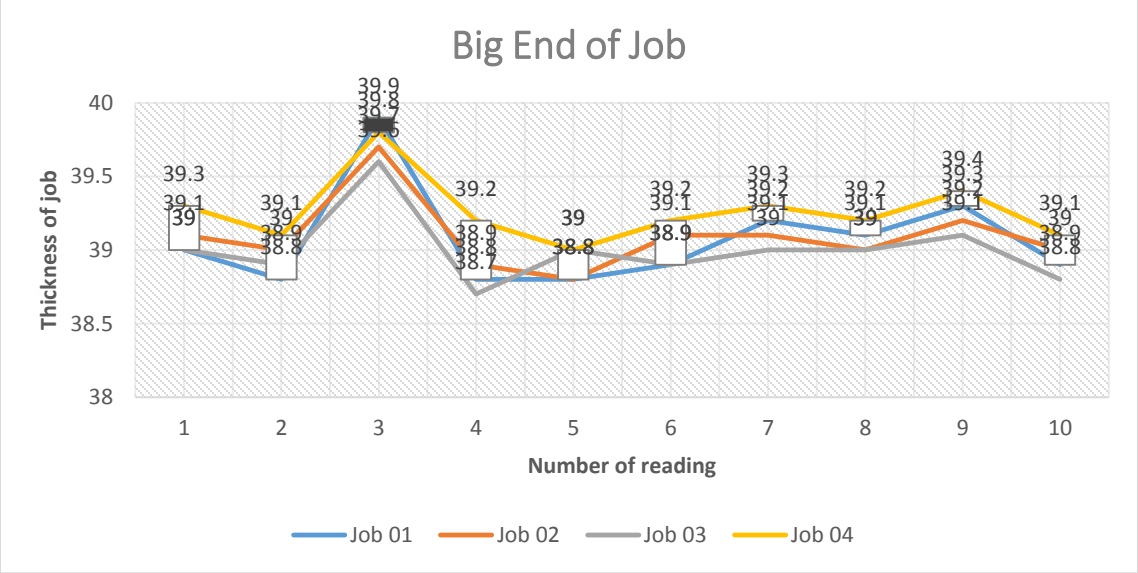


Fig.06 Big End Measurement

I-Section measurement in that we observed that thickness of job get varied in 19.00 mm to 20.4 mm with their basic size. Variation are found + 1.4mm and approximate. Which indicating by bellow graphical presentation.

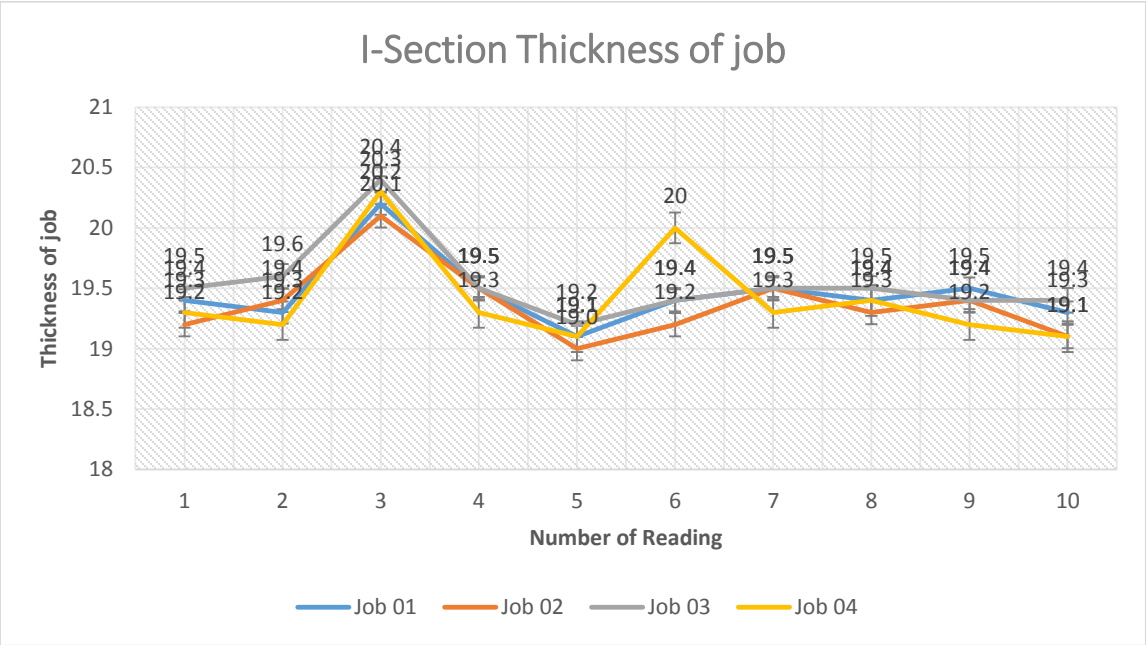


Fig.07 I-Section Measurement

Analyses of Connecting Rod Untrim Component

Small end measurement in that we observed that thickness of job get varied up to 39.9mm with their basic size. Variation are found $+09.mm$ mm approximate. Which indicating by bellow graphical presentation.

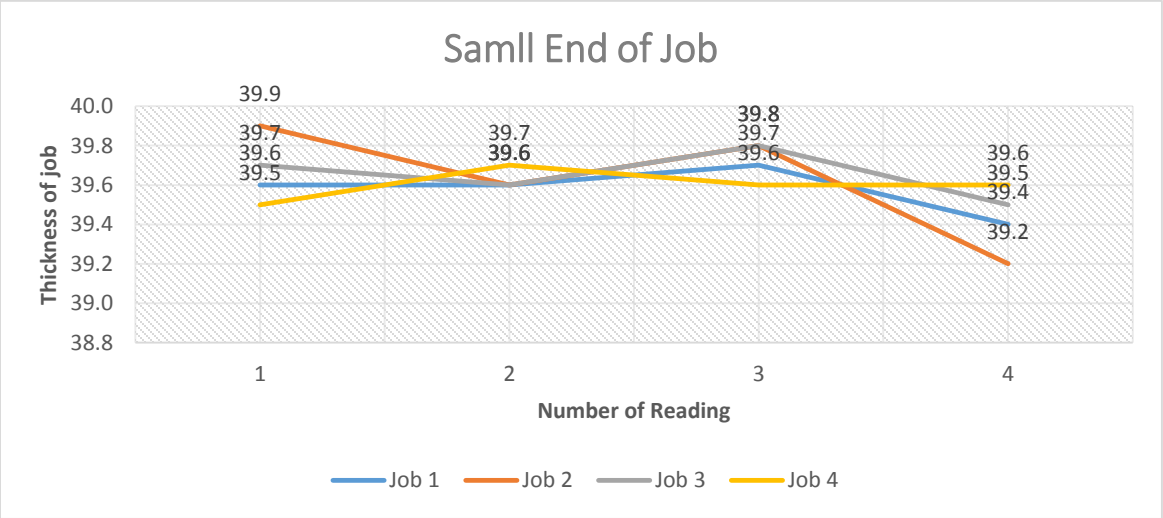


Fig.08 Samll End Measurement

Big end measurement in that we observed that thickness of job get up to 40.2 mm with their basic size. Variation are found +1.1 mm and approximate. Which indicating by bellow graphical presentation.

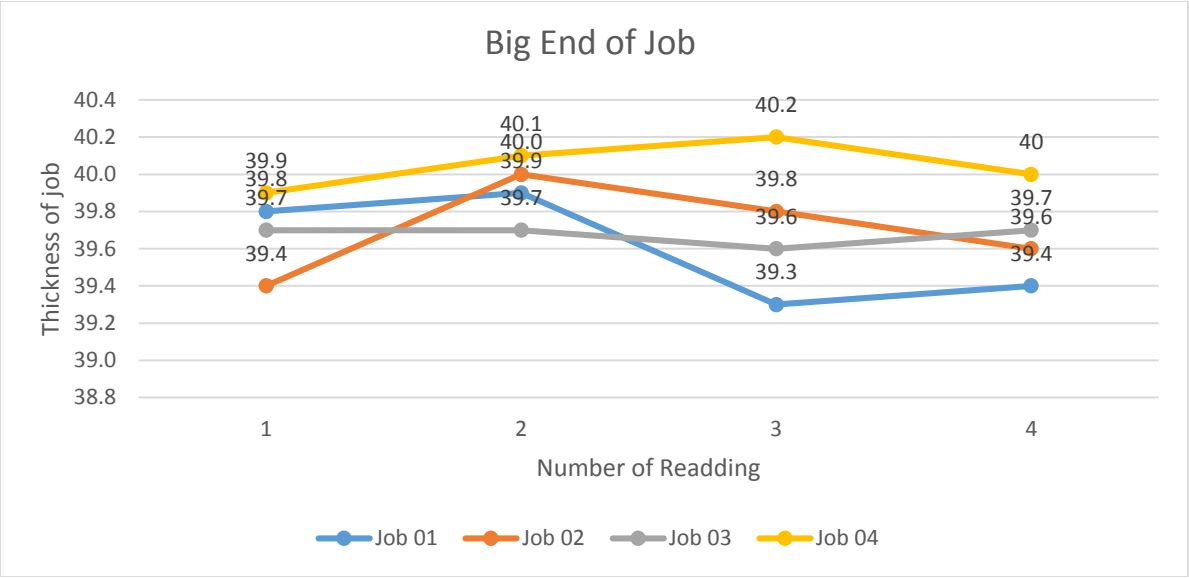


Fig.09 Big End Measurement

I-Section measurement in that we observed that thickness of job get up to 20.4 mm with their basic size. Variation are found + 1.4mm and approximate. Which indicating by bellow graphical presentation.

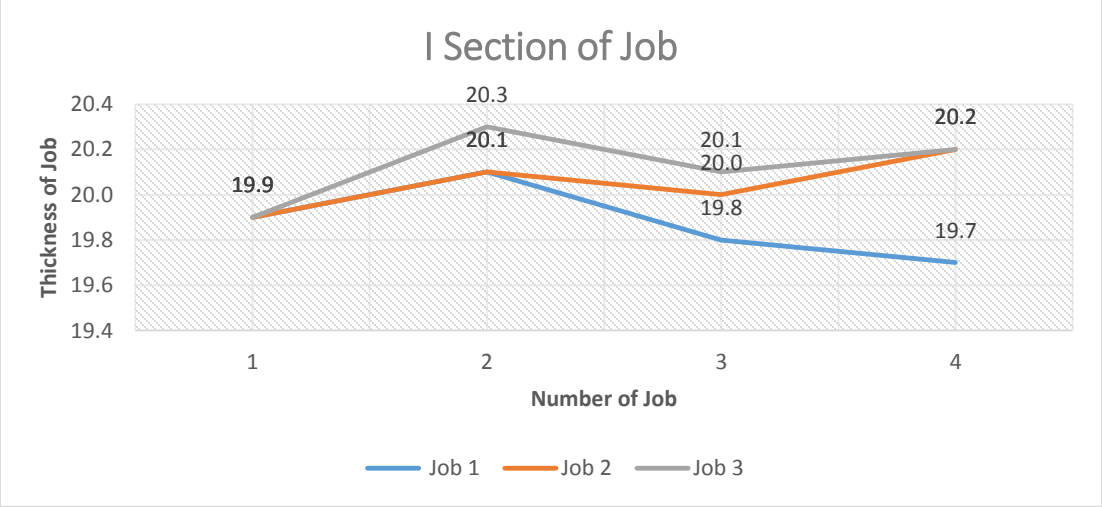


Fig.10 I-Section Measurement

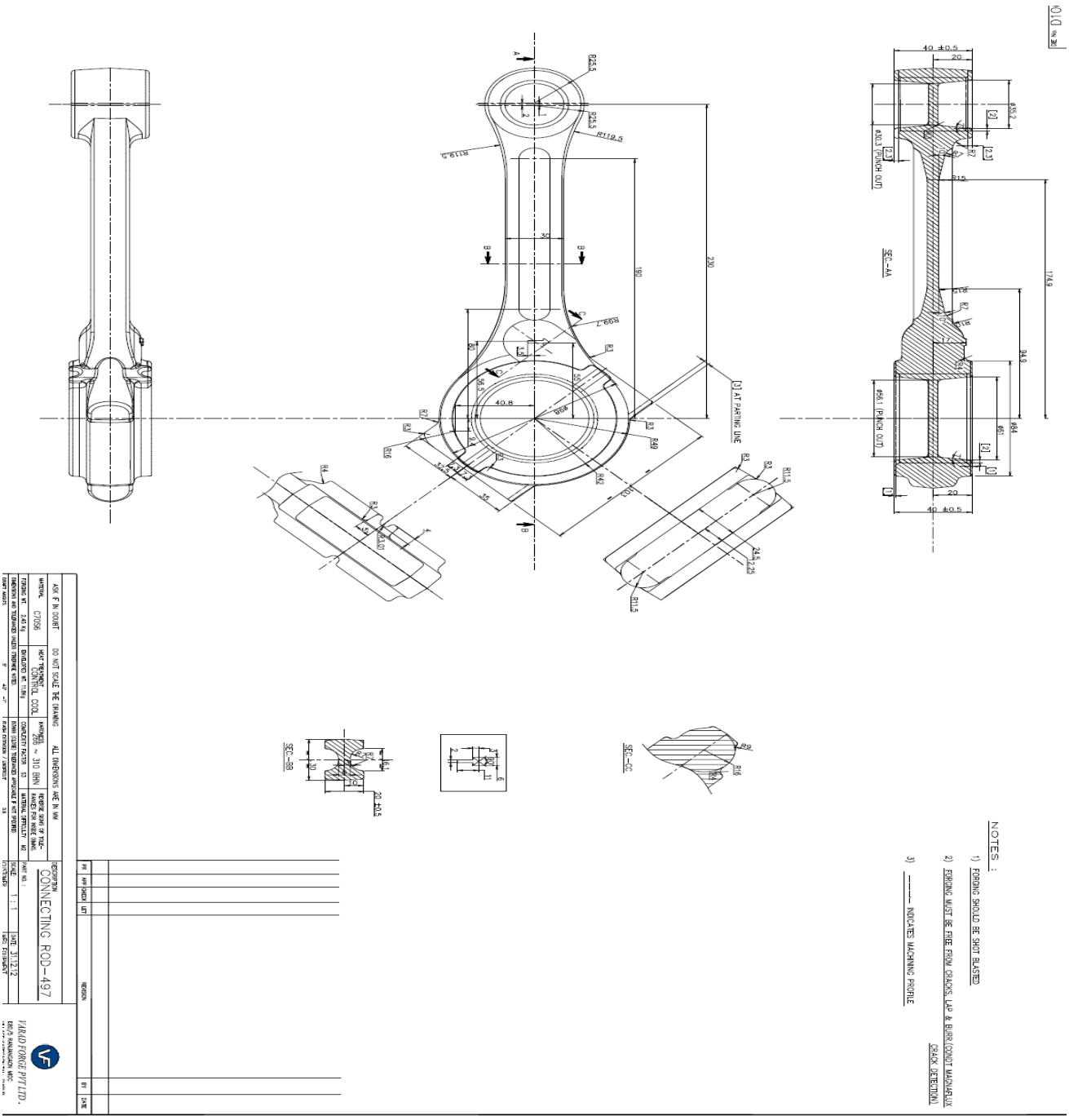


Table 11. Connecting Rod CAD drawing

After that analyses we found some results such as job size get goes under size after trimming but straightness of job get to matinée is very importance so to open some dimensions in trimming die and before that adding one operation to matinee straightness of job such as hot padding operation.

Product analyess by after hot padding opertion

Above analyess of product twsting and size vartion are requried to control by job. Such size vartion are slove by open some trimmming die opertion but size varation of big and small end are not to be control. Such size vartion affacted on further opertion of forging process such as conning opertion.

So controlling such pramerter we adding one addtion opertion in reguler forging opertion. Loction of such opertion find by anlyess of job befor and after trim of job. After that diside such opertion are done by berfor trimming opertion so we can done one additional opertion such hotpadding opertion.

1. Temperature measurement -1. Forging process temperature
   2- Trimming process
   3. After trimming conveyer temperature.
   4. Conveyer Exit temperature.

PART NAME : CON ROD	**Control Cooling**	DATE :-
PART NO : LML-TDG-P3-03		4/14/2015
CUSTOMER : LOKESH Mc		
VFPL DRG NO.: D106-01		

Temperature Measurement (°C)

Hardness:-280-285BHN

Sr.No.	IBH	Trimming Entry	Conv.Entry	Conv.Exit.	Remarks
1	1247	1081	920	400	
2	1261	1024	934	398	
3	1252	1103	910	350	
4	1239	1103	860	317	
5	1254	1085	927	314	
6	1241	1100	974	272	
7	1249	1102	930	285	
8	1208	1100	944	329	
9	1219	1098	951	304	
10	1232	1027	902	334	
11	1230	1098	939	330	
12	1203	1118	906	343	

13	1213	1107	900	280	
14	1212	1118	870	317	
15	1251	1107	920	255	
23	1231	1057	918	304	
Range	**1200-1250**	**1000-1050**	**900-950**	**400-450**	

Table 04 Temperature Measurement After Padding

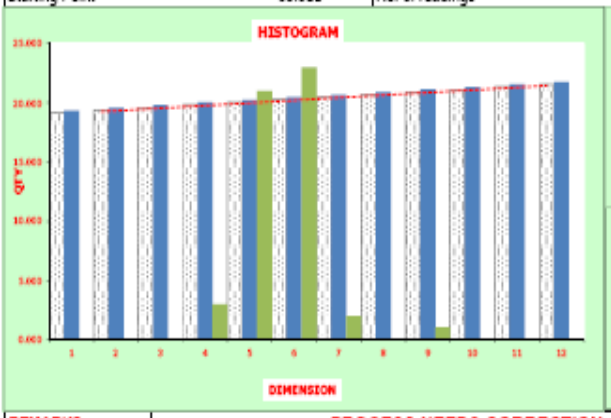
Analyses of Connecting Rod after Hot padding operation

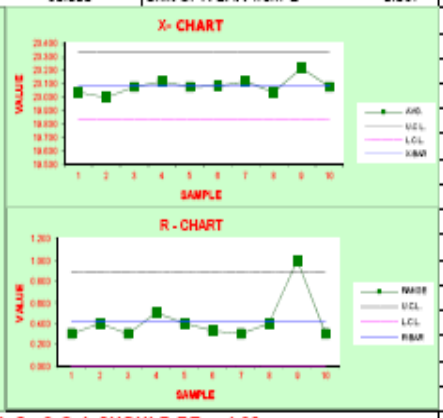
Small end and Big end measurement in that we observed that thickness of job get varied in 40.200mm to 39.800 mm with their basic size. Variation are found ±0.2mm approximate. Which indicating by bellow graphical presentation.

STATISTICAL PROCESS CONTROL STUDY

NAME:	CON ROD		INSTRUMENT:	Vernier Caliper		L.COUNT:	0.02		SUPPLIER							
PART NO.:	007500050C2		SPECIFIC:	40.500 / 39.500		MACHINE:	Forging Press 2000T			DATE-21/10/2022						
SAMPLE SIZE:	50 NOS.		OPERATION:	Final Inspection		NO.OF DECIMALS:	2	D.C. NO.			QTY.	50 Nos				
DATA COLLECTION: -																
SNO.	1	2	3	4	5	6	7	8	9	10	U.T.L.	40.500	SAMPLE	D2	A2	D4
1	40.200	40.000	39.900	40.200	40.200	40.200	40.300	40.200	40.000	40.100			4	1.123	2.560	3.270
2	40.000	40.200	40.200	40.400	40.000	40.100	40.100	39.800	40.200	40.200			12	1.128	1.860	3.270
3	39.900	40.000	40.100	40.000	40.200	39.900	40.000	40.200	40.100	39.900	L.T.L.	39.500	20	1.693	1.020	2.570
4	40.000	39.800	40.200	39.900	39.800	40.000	40.200	40.000	39.900	40.000			20	2.059	0.730	2.230
5	40.100	40.000	40.000	40.100	40.200	40.230	40.000	40.000	39.900	40.200			20	2.326	0.590	2.110
CALCULATIONS: -																
FOR HISTOGRAM																
X_{LARGE}	40.200	40.200	40.200	40.400	40.200	40.230	40.300	40.200	40.200	40.200	Xmax.=	40.400	NO.OF NON CONFORMING PART =			0 NOS.
X_{SMALL}	39.900	39.800	39.900	39.900	39.800	39.900	40.000	39.800	39.900	39.900	Xmin.=	39.800				
RANGE	0.300	0.400	0.300	0.500	0.400	0.330	0.300	0.400	0.300	0.300	R - BAR =	0.353	NO. OF PARTS ABOVE U.T.L. =			0 NOS.
AVG.	40.040	40.000	40.080	40.120	40.080	40.086	40.120	40.040	40.020	40.080	X - BAR =	40.067	NO. OF PARTS BELOW L.T.L. =			0 NOS.

Process Width (P) =	0.600	Specification Width(S) =	1.000	Index (K)=[2 x (D-XBAR) / S]=	0.133	INTERVAL		FREQ.	CU. FREQ.
Design Centre (D) =	40.000	Interval =	0.120	Selecting no. of classes =	5	39.440	39.560	0	0
Starting Point =	39.800	No. of readings=	50.000	Shift Of 'X-BAR' from 'D' =	0.067	39.560	39.680	0	0
						39.680	39.800	0	0
						39.800	39.920	3	3
						39.920	40.040	7	10
						40.040	40.160	15	25
						40.160	40.280	7	32
						40.280	40.401	16	48
						40.401	40.521	2	50
						40.521	40.641	0	50
						40.641	40.761	0	50
						40.761	40.881	0	50
						U.C.L.$_{XBAR}$ =		40.275	
						L.C.L.$_{XBAR}$ =		39.858	
						U.C.L.$_{RBAR}$ =		0.745	
						L.C.L.$_{RBAR}$ =		0.000	
						Std.Dev."s"=		0.139	
						Cp={S/6s}=		1.203	
						Cpk={1-K}xCp}=		1.042	





REMARKS: - PROCESS NEEDS CORRECTION ,Cp & Cpk SHOULD BE >=1.33

Table 04 after Hot Padding Analyses Of Connecting Rod Big End.

I-Section measurement in that we observed that thickness of job get varied in 19.900 mm to 20.200 mm with their basic size. Variation are found $\pm 0.200mm$ mm and approximate. Which indicating by bellow graphical presentation.

STATISTICAL PROCESS CONTROL STUDY

PART NAME:		CON ROD			INSTRUMENT:		Vernier Caliper			L.COUNT:		0.02		SUPPLIER		
PART NO.:		007500050C2			SPECIFIC:		20.500 / 19.500			MACHINE:		Forging Press 2000T			DATE-21/01/2014	
SAMPLE SIZE:		50 NOS.			OPERATION:		Final Inspection			NO.OF DECIMALS:		2	D.C. NO.		QTY.	50 Nos
DATA COLLECTION: -																
SNO.	1	2	3	4	5	6	7	8	9	10	U.T.L.	20.500		SAMPLE	D2	A2	D4
1	20.200	20.000	19.900	20.200	20.200	20.200	20.300	20.200	20.000	20.100				1	1.123	2.560	3.270
2	20.000	20.200	20.200	20.400	20.000	20.100	20.100	19.800	20.200	20.200				2	1.128	1.880	3.270
3	19.900	20.000	20.100	20.000	20.200	19.900	20.000	20.200	20.100	19.900	L.T.L.	19.500		3	1.693	1.020	2.570
4	20.000	19.800	20.200	19.900	19.800	20.000	20.200	20.000	19.900	20.000				4	2.059	0.730	2.230
5	20.100	20.000	20.000	20.100	20.200	20.230	20.000	20.000	20.900	20.200				5	2.326	0.590	2.110
CALCULATIONS: -																	
FOR HISTOGRAM																	
X_{LARGE}	20.200	20.200	20.200	20.400	20.200	20.230	20.300	20.200	20.900	20.200	Xmax.=	20.900	NO.OF NON CONFORMING PART =		1 NOS.		
X_{SMALL}	19.900	19.800	19.900	19.900	19.800	19.900	20.000	19.800	19.900	19.900	Xmin.=	19.800					
RANGE	0.300	0.400	0.300	0.500	0.400	0.330	0.300	0.400	1.000	0.300	R - BAR =	0.423	NO. OF PARTS ABOVE U.T.L. =		1 NOS.		
AVG.	20.040	20.000	20.080	20.120	20.080	20.086	20.120	20.040	20.220	20.080	X - BAR =	20.087	NO. OF PARTS BELOW L.T.L. =		0 NOS.		
Process Width (P) =			1.100		Specification Width(S) =			1.000		Index (K)={2 x (D-XBAR) / S}=		0.173	INTERVAL		FREQ.	CU. FREQ.	
Design Centre (D) =			20.000		Interval =			0.220		Selecting no. of classes =		5	19.140	19.360	0	0	
Starting Point =			19.800		No. of readings=			50.000		Shift Of 'X-BAR' from 'D' =		0.087	19.360	19.580	0	0	
													19.580	19.800	0	0	
													19.800	20.020	3	3	
													20.020	20.240	21	24	
													20.240	20.460	23	47	
													20.460	20.680	2	49	
													20.680	20.900	0	49	
													20.900	21.120	1	50	
													21.120	21.340	0	50	
													21.340	21.560	0	50	
													21.560	21.780	0	50	
													U.C.L.$_{XBAR}$ =		20.336		
													L.C.L.$_{XBAR}$ =		19.837		
													U.C.L.$_{RBAR}$ =		0.893		
													L.C.L.$_{RBAR}$ =		0.000		
													Std.Dev."s"=		0.180		
													Cp={S/6s}=		0.926		
REMARKS: -					PROCESS NEEDS CORRECTION ,Cp & Cpk SHOULD BE >=1.33								Cpk={1-K}xCp}=		0.766		

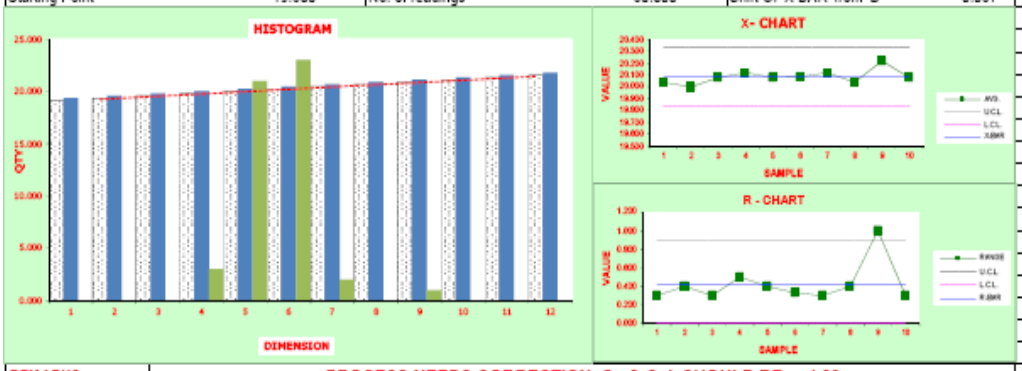


Table 05 After Hot Padding Analyses Of Connecting Rod I-Section Of Job.

Conclusion

After that all analyses data we get some results that are any forging operation product control system done after correction by of forging operation. In that paper we trying to controlling twisting and bending defects in forging operation by adding one new operation. Hot padding is one of the additional operation we adding to control the product defect which are from by forging process.

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