

DEVELOPMENT OF LOW NICKEL STAINLESS STEEL (LNSS)

BY

S SISODIA

DY GENERAL MANAGER (QUALITY)

STEEL AUTHORITY OF INDIA LTD

SALEM STEEL PLANT

E-mail : metserv@sailssp.in

NEED FOR LOW NICKEL STAINLESS STEEL

- **AUSTENITIC STAINLESS STEELS ARE WIDELY USED IN UTENSIL / APPLIANCE AND VARIOUS ENGINEERING APPLICATIONS. THESE STEEL CONTAIN NICKEL 6 TO 24% AND WIDELY REFERRED AS 300 SERIES.**

- **IN THE LATE 1930 & 1940, SHORTAGE OF NICKEL INSPIRED RESEARCHERS TO REPLACE NICKEL WITH NITROGEN & MANGANESE TO STABILISE AUSTENITE. THESE STEELS WERE REFERRED AS 200 SERIES.**

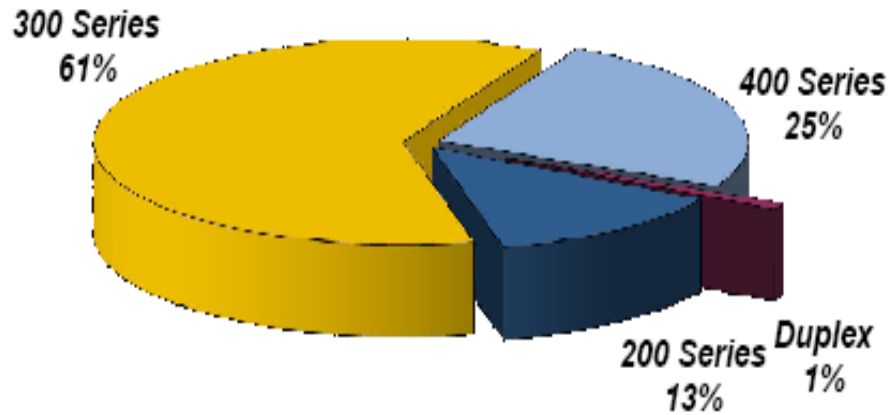
- **THESE STEELS COULD NOT GET WIDE ACCEPTANCE DUE TO;**
 - **LOWER DUCTILITY**
 - **INFERIOR CORROSION RESISTANCE**
 - **SEVERE WORK HARDENING DURING FORMING**
 - **HIGH COST OF PRODUCTION**

NEED FOR LOW NICKEL STAINLESS STEEL

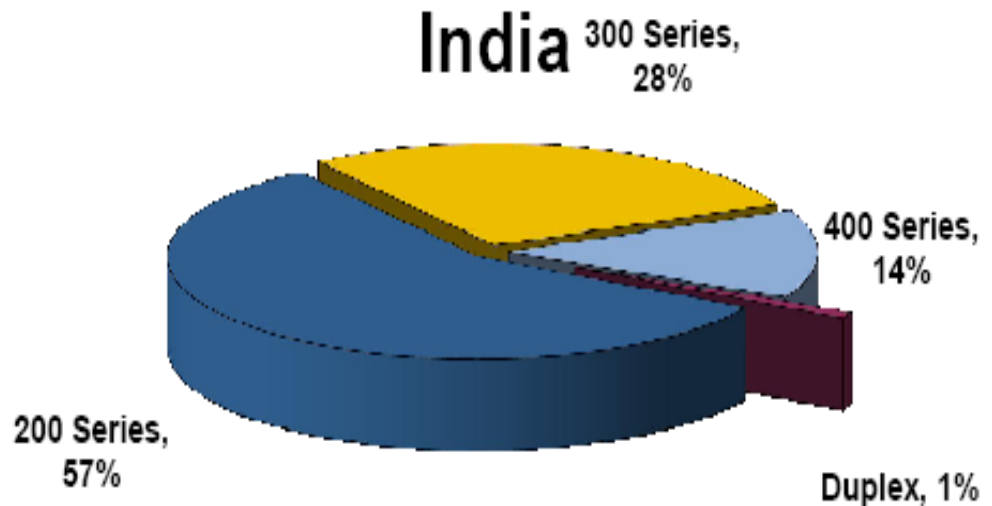
- **IN THE LATE 1980, INDIAN STAINLESS STEEL INDUSTRY EVOLVED A VARIANT OF 200 SERIES WHEREIN ADDITION TO Mn & N, Cu WAS ADDED TO IMPROVE DUCTILITY.**
- **THESE GRADES IS BEING MARKETED BY THE PRODUCERS AS A PROPRIETARY GRADE IN Ni RANGE FROM AS LOW AS 0.2% TO 4%.**
- **INDIAN EXPERIENCE OF THESE GRADE FOUND WIDE ACCEPTANCE IN UTENSIL AND APPLIANCE SECTOR NOT ONLY IN DOMESTIC MARKET BUT ALSO IN THE SOUTH EAST COUNTRIES INCLUDING CHINA.**
- **POPULARITY OF THESE GRADES CAN BE VISUALISED BY THE FACT THAT IN INDIA THEY OCCUPY 57% MARKET SHARE.**

MARKET SHARE OF LNSS

World



India



NEED FOR LOW NICKEL STAINLESS STEEL

- **THESE GRADES ARE BEING MARKETED AS PROPRIETARY COMPOSITION AND DO NOT CONFORM TO ANY NATIONAL & INTERNATIONAL STANDARDS.**
- **THERE WAS NO SYSTEMATIC DATA AVAILABLE ABOUT CORROSION RESISTANCE IN VARIOUS FOOD ACIDS AND SALTS USED IN COOKING AND LONG TERM IMPACT ON THEIR USAGE.**
- **THESE GRADES FAILED TO GET ACCEPTANCE IN ADVANCED ECONOMICS LIKE EUROPEAN UNION AND NORTH AMERICAN.**

ADVANTAGES OF LOW NICKEL STAINLESS STEEL

- **USE OF NITROGEN, MANGANESE AND COPPER TO REPLACE COSTLY NICKEL IS VERY COST EFFECTIVE METHOD FOR PRODUCING AUSTENITIC STAINLESS STEEL.**
- **ALL RAW MATERIALS ARE INDIGENOUSLY AVAILABLE WHICH SAVE FOREIGN EXCHANGE IN IMPORT OF NICKEL.**
- **THESE GRADES EXHIBITED GOOD STRENGTH TO WEIGHT RATIO.**
- **GOOD FABRICATION PROPERTIES I.E. FORMING, DEEP DRAWING AND WELDING.**
- **FIRE RESISTANT.**
- **LOW LIFE CYCLE COST.**

INITIATION OF BIS STANDARD

- **BUREAU OF INDIAN STANDARD (BIS) HAS TAKEN INITIATIVE TO STANDARDISE THESE LNSS UNDER BIS STANDARD.**
- **BIS, ALLOY STEEL & FORGING SECTIONAL COMMITTEE, MTD16 IN THEIR MEETING ON 18.05.2006 DECIDED TO FORM TECHNICAL SUBCOMMITTEE TO REVIEW LNSS AND EVALUATE THE CHARACTERISTICS AND SUBMIT DRAFT STANDARD.**
- **COMMITTEE DECIDED TO ADOPT 3 GRADES IN LNSS FOR DETAILED EVALUATION. SAMPLES OF 0.50 MM COLD ROLLED STAINLESS STEEL IN 3 GRADES ALONG WITH 304 GRADE SENT TO CFTRI, MYSORE FOR EVALUATION IN VARIOUS SIMULATED & ACTUAL FOOD MEDIA AND TCR ENGINEERING SERVICES, MUMBAI FOR PHYSICAL, MECHANICAL, AND CHEMICAL TESTING.**

CFTRI TEST RESULTS

SAMPLE DETAILS

- 1. 3 HEATS IN EACH LNSS GRADE.**
- 2. ONE HEAT IN 304 GRADE.**
- 3. FIVE PLAIN SAMPLE AND ONE DRAWN COOKWARE FROM EACH HEAT USED FOR STUDY.**

CFTRI TEST RESULTS

3 LNSS GRADES, 1%, 1.5%, & 4% Ni RESPECTIVELY WERE TAKEN ALONG WITH 304 GRADE FOR LEACHING STUDIES IN 6 FOOD SIMULATIONS AND 4 ACTUAL FOOD MEDIA .

A. FOOD SIMULANTS

SL.NO.	MEDIA	VALUE OF pH	TEMP	DURATION
1	3% ACETIC ACID	2.59	BOILING	30 MINUTES
2	3% CITRIC ACID	2.82		
3	3% LACTIC ACID	2.80		
4	1% TARTARIC ACID	2.27		
5	10% ETHNAL	5.82		
6	DISTILLED WATER	6.8		

B. FOOD ITEM

SL.NO.	FOOD ITEM	VALUE OF pH	TEMP	DURATION
1	4% COMMON SALT	6.10	BOILING	30 MINUTES
2	REFINED SUNFLOWER OIL	1.6		
3	COOKED ARHAR DAL	6.2		
4	FULL CREAM MILK	6.4		

CONCLUSION

CFTRI BASED ON STUDY CONCLUDED FOLLOWING:

- **ALL LNSS GRADES SHOWN SIMILAR LEACHING PHENOMENON AS OBSERVED IN 304 GRADE IN SIMULATED FOOD MEDIA AND FOOD ITEMS.**
- **TEST COUPONS HAS NOT EXHIBITED ANY SURFACE CORROSION / RUST MARK AFTER TESTING.**
- **THE TESTED LNSS ARE FOOD COMPATIBLE.**

TEST RESULT OF EXAMINATION AT TCR LABORATORY

3 HEATS IN EACH LNSS GRADE WERE TESTED FOR MECHANICAL PROPERTIES, DRAWABILITY AND MICROSTRUCTURE.

A. 4% NICKEL

	LONGITUDINAL	TRANSVERSE
0.2% PROOF STRESS	303 – 411 N/mm²	313 – 439 N/mm²
UTS	721 – 765 N/mm²	710 – 753 N/mm²
ELONGATION	40 – 41%	45 – 49%
FERRITE	< 0.25%	
GRAIN SIZE	ASTM NO. 8 - 9	
HARDNESS	199 – 208 (H_v 5) / 91 – 93 HR_B	
CUPPING TEST	11.4 – 11.8 mm	

TEST RESULT OF EXAMINATION AT TCR LABORATORY

B. 1.5% NICKEL

	LONGITUDINAL	TRANSVERSE
0.2% PROOF STRESS	412 – 492 N/mm²	356 – 477 N/mm²
UTS	763 – 855 N/mm²	774 – 854 N/mm²
ELONGATION	40 – 43%	40 – 50%
FERRITE	< 0.25%	
GRAIN SIZE	ASTM NO. 9	
HARDNESS	232 – 241 (H_V 5) / 97 – 98 HR_B	
CUPPING TEST	11.5 – 11.8 mm	

TEST RESULT OF EXAMINATION AT TCR LABORATORY

C. 1% NICKEL

	LONGITUDINAL	TRANSVERSE
0.2% PROOF STRESS	432 – 472 N/mm²	332 – 482 N/mm²
UTS	874 – 900 N/mm²	794 – 862 N/mm²
ELONGATION	40 – 50%	43 – 52%
FERRITE	< 0.25%	
GRAIN SIZE	ASTM NO. 9	
HARDNESS	239 – 246 (H_V 5) / 98 – 99 HR_B	
CUPPING TEST	11.5 – 12.9 mm	

CONCLUSION : MATERIAL IS HAVING GOOD DUCTILITY FOR DEEP DRAWING AND FORMING.

BIS STANDARD – IS 15997 : 2012

1. SCOPE

THIS STANDARD COVERS THE REQUIREMENT FOR LN AUSTENITIC STAINLESS STEEL SHEET & STRIPS FOR MANUFACTURING OF UTENSIL AND KITCHEN APPLIANCES.

2. SUPPLY CONDITION

MATERIAL SHLL BE SUPPLIED IN SOLUTION ANNEALED CONDITION WITH FOLLOWING PARTICULARS TO BE SPECIFIED BY PURCHASER:

GRADE DESIGNATION	N1, N2 & N3
THICKNESS	0.20 TO 4.00 mm
FORM	SHEET / STRIP
NOMINAL WIDTH	1500 mm MAX.
LENGTH	AS PER MUTAL AGREEMENT
SURFACE FINISH	NO.1, 2D, NO.3, NO.4
EDGE CONDITON	ME / TE

BIS STANDARD – IS 15997 : 2012

GRADE DESIGNATION	CHEMICAL COMPOSITION (%)				
N1	C	Si	Mn	Ni	Cr
	0.12 MAX	0.75 MAX	8.5 – 10.5	1 – 2	14.5 – 16.0
	S	P	Cu	N	
	0.03 MAX	0.08 MAX	1.5 – 2.5	0.08 – 0.2	
N2	C	Si	Mn	Ni	Cr
	0.10 MAX	1.00 MAX	6.5 – 9.0	1.5 – 3.5	15.5 – 17.0
	S	P	Cu	N	
	0.03 MAX	0.07 MAX	2 – 4	0.1 – 0.25	
N3	C	Si	Mn	Ni	Cr
	0.09 MAX	0.75 MAX	6 – 8	4 – 6	16 – 17.5
	S	P	Cu	N	
	0.03 MAX	0.07 MAX	1.5 – 2.5	0.05– 0.15	

MECHANICAL PROPERTIES

GRADE DESIGNATION	0.2% YIELD STRENGTH N/mm² (Min)	UTS N/mm² (Min)	% ELONGATION (Min)
N1	345	650	40
N2	310	650	40
N3	275	600	40

ERICHSEN CUPPING TEST

THICKNESS RANGE (MM)	AVERAGE DEPTH OF CUP (MM) Min
0.20 – 1.25	10

DIMENSIONAL TOLERANCES

**SPECIFICATION SPECIFY MAXIMUM PERMISSIBLE
VARIATION IN THICKNESS, WIDTH, LENGTH AND CAMBER.**

MATERIAL TEST REPORT

TEST REPORT REQUIRED BY THE STANDARD AND MANUFACTURER'S CERTIFICATION FOR CONFORMING TO THE STANDARD.

BIS CERTIFICATION MARKING

LICENCE FOR USE OF STANDARD MARK IS GRANTED TO MANUFACTURERS BY BUREAU OF INDIAN STANDARDS.

THANK YOU