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JORDAN

Technical report: Production, galvanizing and quality control for steel pipe manufacture and upgradation of Arabian steel pipe manufacturing company*

Prepared for the Government of Jordan
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of S. C. Anand, steel pipes expert

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United Nations Industrial Development Organization
Vienna

* Mention of company names and commercial products does not imply the endorsement of UNIDO. This document has not been edited.

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INTRODUCTION

The consultant arrived Amman on 5th. December 1989 after one day briefing at Vienna. He reported at UNDP office on 6th.instant, met ministry of industry offical and commenced work at the duty station i.e Arabian Steel Pipe Manufacturing Company Sahab the same day.

Chief of plant authorities advised the consultant to review the existing manufacturing operations, advise on manufacture of A.S.T.M. pipes, introduction of quality control system, capacity increase and rolls design for sectional tubes for the bigger mill.

The said plant is in private sector and has some financial participation from Government. It it equipped to manufacture black and galvanised pipes in the size range ½" N.B to 6" N.B to specifications BS 1387/85 of production capacity 30,000 Tonnes/ annum on single shift basis.

It has one slitting line, one tube mill of size range ½"-2",& 2nd tube mill of size range 2"-6" with necessary finishing equipment and one galvanising plant to cover size range of ½"-2". Tube mills are supplied by M/S Voest- Alpine, slitting line & Finishing Equipment by WYKO and galvanizing plant by M/S LECO.

It is observed that overall plant layout is very congested and there is hardly any intermediate pipe storage space provided in between tube mills and finishing machines- inspite of the fact that capacity of hydraulic testing machines is nearly half to that of mill and endfacing machines.

Plant authorities have employed Four . Libanese technitions with previous experience on tube plant operations. However excepting their General Manager(who is incharge of total operations including finance & marketing), presently they donot have any technical person with previous experience in tube plant operations.

Production trial runs were commenced during March & May 1989 and markeeting during the middle of 1989.

Brief job description as advised by UNIDO- Vienna is given on the next page.

Purpose of the Project:

The project is aimned at laying the foundation for an upgrading of maintenance and operational routines in different enterprises.
The main emphasis is to identify bottlenecks and shortfall and to participate in improving installations work routines and conditions in co-operation with counterparts and officials.

Duties of Consultant

Investigate the current situation with manufacturing steel pipes and existing plans for commissioning.
To advise on necessary arrangements to upgrade the manufacture of steel pipes.
To assist in drawing a work plan for operations and maintenance.
Give guidelines for the development and implemantation of suitable training programmes to upgrade the capabilities of the national counterpart.

Project duration of consultant

One month including briefing/debriefing in Vienna and travel time.

Abstract

Quality of pipes being produced, is good & plant is being managed very professionally. Plant authorities are very progressive and aim to produce quality product with major emphasis on exports. Within the short span of six months of their commencement of production, they have already received orders for export of pipes . Keeping in mind internal pipe demand constraints; they have rightly budgeted exports of 10 Million U.S. Dollars during the year 1990.

In addition, they want to diversify in production of pipes to ASTM-A-53 specification for export to U.S.A, and bigger sectional tubes on the 2nd mill. Their immediate objectives are:-

i)- To maximise export earnings
ii)- To effect savings in foreign exchange by import substitution.
iii)- To effect economy by production increase .
iv)- To effect economy by control over use of costly inputs i.e. zinc, galvanising chemicals, mill rolls etc.
v)- Product diversification etc.

It is observed that presently, plant authorities donot have necessary experianced technical engineers with past experience in tube industry, to meet the desired objectives. It is suggested that one person with international markeeting experience and minimum one engineer with adequate experience in production and tube galvanising is made available for a period of approx. 6 months to stream line operations.

In addition, training of their engineers in pipe production/galvanising technology abroad shall be helpful.

Consultant during his brief period of stay (approx. 3 weeks) could cover some areas only . His detailedreport covering importment production areas is enclosed.

Summary of Important Recommendations

Though recommendations on various subjects covered in the body of report, are summarised at the end of each chapter; however important one's are being re-produced:-

Galvanising Section

1)- Better control over zinc consumption during pipe galvanising process to avoid giving heavier zinc coatings on pipes than desired- without sacrifising pipe quality. It could result in appreciable savings.

It requires the following steps:-

i)- Zinc balance sheet to be drawn every month indicating total surface area galvanised, zinc consumned and to arrive at zinc consumption in gms per square meter. It should be between 700 to 750 grs/sq meter as against present observed of 860 gms/sq meter.

ii)-Zinc coating tests by stripping process to be conducted every shift to know averge of outside and inside coating- which should be as close as possible to the desired of 400 gms/sq meter. Results of zinc coating tests should be available to galvanising engineer in a short interval of half an hour to enable him to adjust suitable galvanising parameters.

(On trial basis,arrangements were made to conduct these tests and these can be continued without any equipment addition)

iii)- Zinc by-products i.e. Dross, Ash and Blowing dust recovered each month to be weighed and compared with the standards. Formation of zinc dross and

zinc ash to be minimised to 8% and 16% of total zinc consumption where as zinc dust (blowings) to be maximised (approx. 12-15% on current pipe size range of ½" to 2")

iii)-Galvanizing plant to be modified to enable to extract pipes at 14° angle inplace of present one of 12°, (It can be done without major changes) which would allow better zinc drainage from pipe inside surface, resulting in saving of zinc consumption.

2. Indigenous available caustic soda (sodium hydroxide) to be used for pipe degreasing inplace of importing propriority degreasing agent from West Germany. (cost of indigenous caustic soda is said to be nearly 1/5 of the imported one)
3. To avoid formation of white rust on pipes outersurface, galvanised pipes to be dipped in solution of sodium dichromate to minimise the same.

Tube Mills

1. System of tube mill roll profile checking, rectification of profile of worn out rolls and possibally manufacture of new mill rolls locally to be looked into-which can be done without much addition of plant and machinery.
2. Quality control deptt. to be established, various proposaed tests to be conducted at fixed time intervals and their results noted in prescribed formats.(covered in detail in body of the report)
3. To check pipe thread quality and also of sockets, ring guage and plug guage of various pipe sizes to be imported.
4. Production reporting formats, inparticular of slitting line, tube mill and of galvanizing section to be modified giving necessary setting parameters for ease of their repeatebility in future.
5. To overcome the production capacity limitation of pipe hydraulic testing machines, eddy current tester to be procured for installation in-line of tube mill. It would also meet additional testing requirement of ASTM A-53 pipes, which the company plans to manufacture.
6. System of Raw Material i.e. Hot Rolled Coils, identification by heat no /Coil no. to be introduced, check analysis of physical properties, chemical composition and actual dimensions to be corelated with mill test certificates.

NOTE ON QUALITY OF H.R. COILS AND IT'S INSPECTION PROCEDURE

It is observed that presently HR Coils are being procured with following Chemical Composition:(for detailed spec. refer Page No. 9)

C= 0.2% Max.
Si= 0.04% Max.
Mn= 0.25-0.5%
S= 0.04% Max.
P= 0.04% Max.
N2=0.0009 Max.

I understand from the engineers of Royal Scientific Society that some times Mn content in steel received is observed lower than min. specified and many times tensile strength of pipes is heigher than Max. prescribed in B.S. pipe spec. 1387/85 of 450 N/mm^2.(though Jordan relevant spec. 137/85 has prescribed limit of Max. 520 N/mm^2.

Samples from coil pieces are sent to Royal Scientific Society for chemical and physical analyses. These samples don'not bear coil No and heat no of coil manufacturer.

Mill test certificates received from coil manufacturer are retained by the main office and not sent to the factory manager. Test results of coil samples from Royal Scientific Society are sent to the factory manager.

At present results of chemical composition and physical properties of strip as per mill test certificates and that of Royal Scientific Society are not being compared.

In the chemical analysis of 2 strip samples, Si content as per check analysis was observed by consultant to be 0.28% and 0.42% as against specified in the order of 0.04%Copy of check analysis report of Royal Sientific Society is enclosed on page No. 10.

Recommendation

1. Though present chemical composition is O.K., it is proposed to amend only carbon and manganese range as follows:-

   C= 0.18% Max.

   Mn = 0. 6% Max. (Min. range removed)

Steel with above composition can be easily supplied by manufacturers without any extra price and it would be easier to weld.

The proposed chemical composition shall not only make steel easily weldable but would also avoid any heigher tensile strength in pipes which would meet pipe specifications BS-1387/85

2. It is proposed that one copy of Mill test certificates of strip are sent to the factory manager. In addition, factory manager should indicate coil no and heat no on strip samples before the same are sent for check analysis to Royal Scientific Society.

   Results of both these analysis should be compared and major variation if any should be intimated to the Steel supplier.

H.R. COIL DIMENTIONS

i)- Initially Hot Rolled Coils were procured as per thickness prescribed in the relevant BS pipe spec. 1387/85 without considering tolerances of specifications on pipe thickness and pipe weight which are reproduced below:-

a)- Thickness tolerance

light = -8%

Med. & Heavy =-10%

b)- Weighttolerance

Single tube = +10% - 8%

150 Meter & larger=± 4%

Since pipe weights were found to be heigher by 5 to 6% of standard weights, presently thickness ordered are standard thickness less approx. 3%.

ii)- Coil width are procured as per slitter set up width plus slitting allowance of 10mm on either side is +20mm.

iii)- There is no record maintained of actual strip thicknesses, weights and widths received.

Recommendations

1. Keeping in mind (-) tolerance of pipe specifications and the practice followed by strip manufacturers to supply coils on (+) tolerance, it is recommened to order strips of thicknesses with (-) tolerance of 4%.
   Howeverfor pipe size ½" light thickness recommened is 2mm. Since thread Height of ½" pipe is 1.162 mm. and pipe O.D tolerance is +0.4 mm, effective pipe thickness left over shall be only approx. 0.6 mm on threaded pipe ends-making pipe too weak for wrench tightening.
   Proposed thickness to be ordered for different pipe sizesare given on page No. 22.
2. Proposed slitting allowance is as follows:-
   Up to strip thickness 3=7mm on each side
   above " " 3=1.5T " " "
   Where t = Strip thickness
3. It is strongly recommened that actual coil thickness and width record of different coils is maintained during coil slitting operation.
   In addition coil defects if any, ie slivers, slag, folds, lamination etc. also to be recorded giving coils no., heat no etc. to enable the management to lodge complaint with the supplier.(I understand some steel defects were observed in the past, however due to no: maintenance of coil /slit identification; no complaint could be lodged)
   Format to be used for production, coil dimensions and visual deffect is enclosed on page no. 13

Technical Specifications for Hot Rolled Strips

Quality : RRo St 37-2 Al Killed steel hot rolled coils according DIN 17.100 or JIS G3132 grade SPHT-2.
Or any equivelent specifications, the steel in shape of large strips, unpickled and unoiled.

Application: To be suitable for longitudinaly high frequancy welding for manufacturing gas and waterpipes, black and galvanized, by using hot Dip galvanizing, according BS 1387.

The following basic requirement must be secured by any specifications

1. Chemical analysis: (Max concentration)

C	=	0.2%
Si	=	0.04
Mn	=	0.25-0.5%
P	=	0.04
S	=	0.04
N	=	0.0009

2. Mechanical Properties

Tensile Strength = 320 N/mm2 Min.
450 N/mm2 Max.

Elongation = 25%-30% depends on thickness

Yield strength = 195 N/mm2 Min.

3. Coil weight and Dimensions

Coils I.D 460-540/560-640/712-790

Coil O.D 1600 mm Max.

Coil Wt 10 tons Min. 14.9 tons Max.

4. Tolerence on thickness, flatness camber, coil weights coil inside diameter are according to Din 1016 and/or DIN 1614.

5. Tolerance on widths

Minus 0 plus 20 mm

6. Coil conditions

The coils shall be wound firmly, as circular as possible, coil ends to be square cut without fish-tails and tongues, but some off guage to be allowed at both ends, strips shall be with natural rolled edges and to be free from injurious defects and laminations.

7. Packing :

suitable for sea shipment export and bare hoop bundle.

ROYAL SCIENTIFIC SOCIETY
MECHANICAL ENGINEERING DEPARTMENT
Strength of Materials Laboratory
P.O.Box 925819 Amman Jordan
Phone 844701 Telex 21276

الجمعية العلمية الملكية
دائرة الهندسة الميكانيكية
مختبر فحص قوة المواد
صندوق البريد ٩٢٥٨١٩ عمان الاردن
تلفون ٨٤٤٧٠١ تلكس ٢١٢٧٦

شهادة فحص

TEST CERTIFICATE

Test Performed for M. S THE ARAB STEEL PIPES MANUFACTURING CO.
Samples brought by MR. AHMAD TAWALBA
Your Ref. & Date AGREEMENT
Page No 4 *Total of Pages* 5

Our Ref (3)148/55/1/1/92
Date of Test 22.11.1989
Material STEEL SHEET

TYPE OF TEST CHEMICAL ANALYSIS ACCORDING TO JIS G3132-SPHT2 STANDARDS

Chemical analysis tests were carried out on two samples (1.1,1.2) of steel sheets. The tests has been performed by using carbon and sulphur analysis and SEM with EDX techniques. The results were expressed in weight percentages as shown in the following table :-

Elements	C	S	Si	Mn	P	Remarks
As Required	0.18 Max.	0.04 Max.	0.35 Max.	0.25 - 0.60	0.04 Max.	
Sample No. 1.1	0.12	0.01	0.28	0.01	0.0	Mn & P percentages are low
Sample No. 1.2	0.11	0.01	0.42	0.01	0.0	Si% is higher than the required, while Mn & P percentages are low

ROYAL SCIENTIFIC SOCIETY
MECHANICAL ENGINEERING

Tested by Dr. Akram ... Test Engineer E. Khreis

OPERATING PRACTICE TUBE MILL/SLITTER

SLITTER

1)- As described under note of HR Coil dimensions, no data is maintained on actual coil thickness and widths at different places of coils across the length and width, during the slitting operation. It is recommened to do and follow format given on page no..12..

2)- Presently only 30 mm wide slitting cutters are being used for slitting strips of thickness 1 mm to 5.4 mm. to economise on tooling and its gringing cost, it is recommened to use cutters of 15mm thickness up to 3 mm. and 30 mm. cutters for heigher thicknesses of strip.

TUBE MILL

1. Presently no record is maintained on the tube mill on actual pipe diameter, mill setting, mill spead, weld power consumned and results of pipe tests etc.
   Production reporting for-mat giving necessary technical details has been modified and is given on page no.13 , where as pipe quality test result format on page no.47.

   Details of pipe quality test results etc is covered separatly under the chapter of quality control.

SLITTER PRODUCTION REPORT

Date:.....

1. Detail of Coil Slitted
   a) Coil Size (thickness X Width).....No.of coils slitted... Tonnes.....
   b) Coil Size .....No.of coil slitted.... . Tonnes.....
2. Slits made
   a)pipe size..... Width..... No of coils..... Tonnes.....
   b)Pipe size..... Width.... No of coils.... Tonnes.....
3. Coil details
   Nominal Coil Size(THK.xWidth) .....

Sr.No.	Coil No.	Heat No.	Actual*		Weight	Weight of Rejected Portion
			Thickness	Width		

4. Stoppage Particulars

Reason	From	TO	Duration

5. Remarks.....

*Actual Coil dimentions to be checked across length/width at six places.

Signature Foreman..... Signature Engg.....

TUBE MILL PRODUCTION REPORT

Mill No... Pipe size x Thickness..... Date.....

1. Production Details

   No. of good pipes

   No. of rejected pipes

   Others:- (length, new set up etc.)

2. Stoppage Details

Reason	Category	From	To	Duration

3. Technical Parameters

   - MillSpeed M/mt.....
   - Profile section Amp.....
   - Callibration ,, Amp.....
   - H.F. Power Control Setting....
   - Power start Delay .....
   - Weld Power out put KW.....

4. Spares Consumed

   - Impeder/Induction Coils.....
   - Scarfing tools .....
   - Flying saw blade .....
   - Others

Signature of Mill Forman.... Signature of Eng. .....

NOTE ON PIPE THREADING MACHINE OPERATIONS

1. It is observed that currently pipe end threads and socket threads are not being*at all for thread guage length, guage plane etc. There are no ring and plug guages available for checking pipe and socket thread respectively, though pipes are being threaded to spec. BS 21.

*checked

2. Chaser angles being followed are not very correct. Present grinding angle or cutting angle and rake angle being followed are 0° and 20° irrespective of pipe size.
However manufacture(Wagner) vide his sketch GSL-50 (a copy of which is enclosed on page No. 15.) has recommened that:-
Cutting Angle= Holder Angle+Supplementary Angle.
Chaser Holder angles observed from chaser holders are as follows:-

Pipe size inch	(Helix) angle
½	2.41
3/4&1"	1.83
1½ &2"	1.58
2"	1.4

Supplementry angle as calculated from GSL sketch 50 forlong throat pipe threads is 3.2°. As a result cutting angle for pipe size is worked out to be approx. 1.4+3.2=4.6°

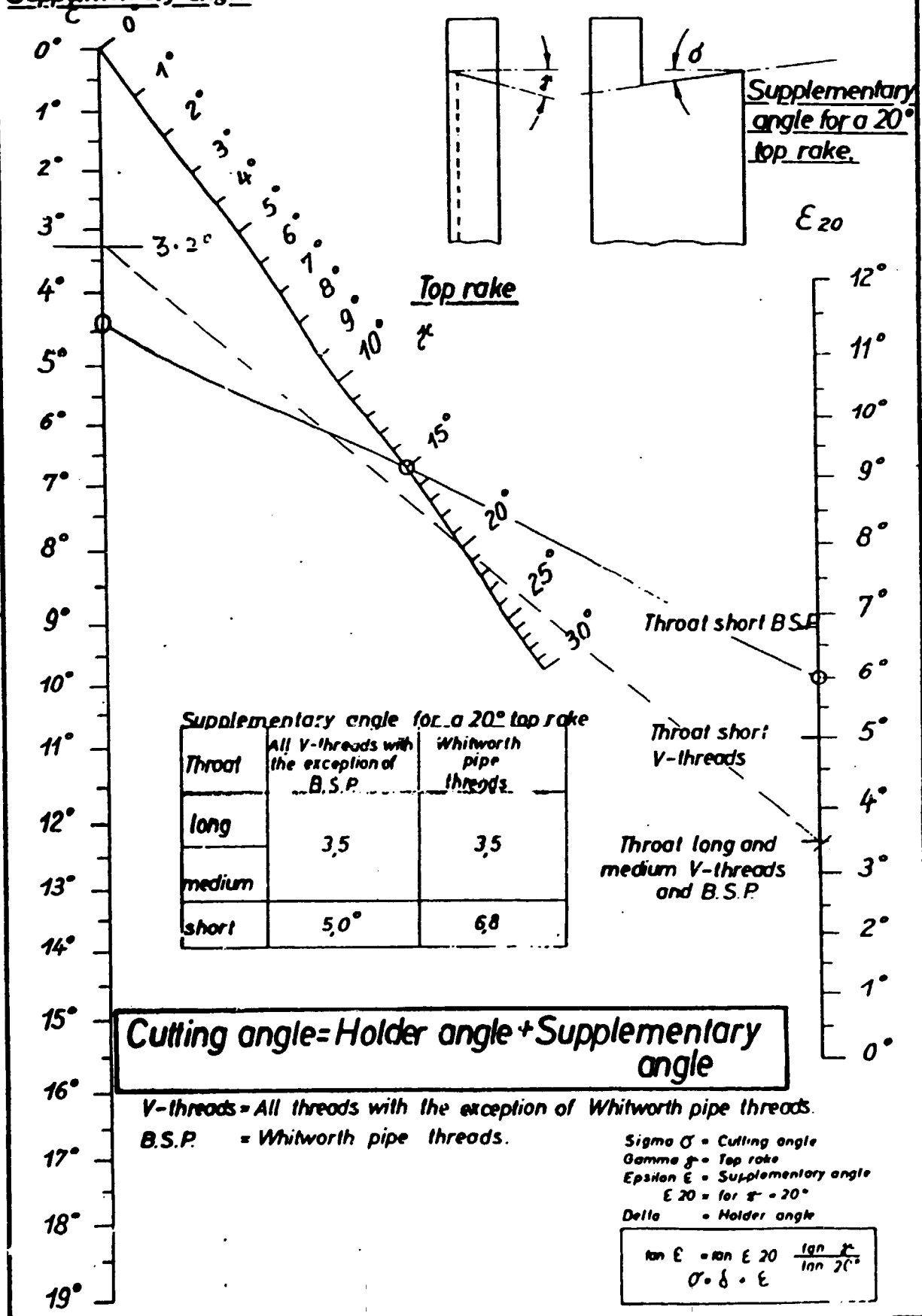
During my stay at the plant, problems were encountered while threading 2" pipes while chaser angles were kept as 0° and 20° for grinding and rake angles respectively. However upon the recommendation of Mr. E.W. Crunpton supplier's Senior commissiong engineer (who was available for a few days) grinding angle was modified to approx. 5° and the threading problem was over come.

3. Presently only **one colour band** of width approx 40 mm. is provided on one pipe end whereas relevant B.S. specification has prescribed the same as one colour band of width 50 mm. wide near each end of pipe for pipes above 4 meter in length.

RECOMMENDATION

1. Ring guages and plug guages (working type and not master one's) to be procured to check pipe and socket threads.These should be as per spec. BS 21 System B.For details refer sheet No. 16
2. Revised cutting chaser angles to be followed as per guide lines given on Wagner sketch GSL 50-a copy of which is enclosed on page No. 15
3. Two colours bands of width approx 50mm, one near the either end of pipes to be provided.

Nomogram for Cutting angle



Supplementary angle for a 20° top rake

Throat	All V-threads with the exception of B.S.P.	Whitworth pipe threads
long	3,5	3,5
medium		
short	5,0°	6,8

Cutting angle = Holder angle + Supplementary angle

V-threads = All threads with the exception of Whitworth pipe threads.

B.S.P. = Whitworth pipe threads.

Sigma σ = Cutting angle
Gamma γ = Top rake
Epsilon ε = Supplementary angle
ε 20 = for γ = 20°
Delta δ = Holder angle

$$\tan \varepsilon = \tan \varepsilon_{20} \frac{\tan \gamma}{\tan 20^\circ}$$

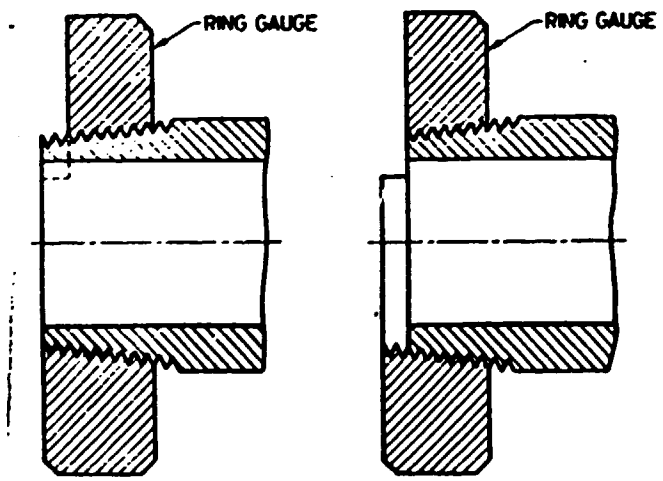
$$\sigma = \delta + \varepsilon$$

GSL50

DETAILS OF SYSTEM B GUAGES

Threaded Ring Gauge- This gauge has a total length of thread equal to the length of use-full thread for maximum gauge length minus half the wrenching allowance, and incorpo-rates a step equal to the total tolerance on the gauge length. The upper face of the step is marked Max and the lower face is marked 'Min'.

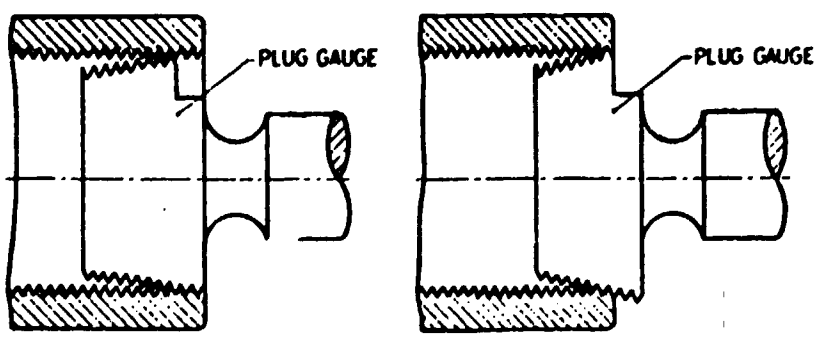
Threaded plug Gauge- This gauge has a total length of thread equal to the length of useful thread for maximum gauge length and incorpo-rates a step equal to the total tolerance on the position of the gauge plane. The upper face of the step is marked 'Max' and the lower face is marked 'Min'.



External Thread of Maximum Gauge Length

External Thread of Minimum Gauge Length

Gauging External Pipe Threads



Internal Thread (Parallel or Taper) of Maximum Size

Internal Thread (Para[redacted] of Minimum Size

TUBE MILL ROLLS

Mill rolls are essential tooling required for making different pipe diameters/ sections. These are the heart of production/ pipe making process and require proper care and maintenance to ensure proper radious of curvature.

Since mill rolls are very expensive, worn out rolls profile should be reconditioned to its original profile and these should not be discarded.

Essential/critical rolls must be kept spare. In the present design of roll-pass, pass No. 1 and welding rolls are essential to be kept spare.

CARE & UPKEEP OF MILL ROLLS

Proper care should be taken for mill rolls handling, storage and upkeep. Profile of rolls should be checked frequently by means of profile guage - to know quantu m of wear and tear.

Presently their does not exixt any system of roll profile checking. Profile guage to check roll wear and also to manufacture new roll on a simple lathe is drawn by the consultant (for reference purpose of one pipe size and pass No on page No. 18 .

Roll history l g book should be maintained for each and every pipe size and pass no, indicating date and period of rolling, tonnage rolled and condition of rolls(quantities of wear)

INDIGENOUS MANUFACTURE OF MILL ROLLS

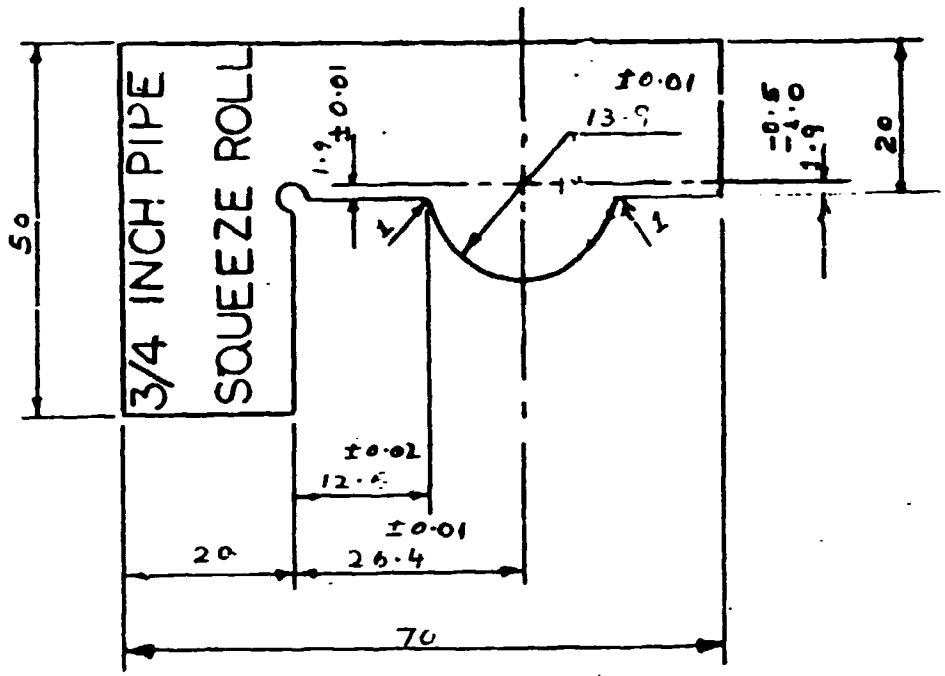
Tube mill rolls can be indigeneusly manufactured on a simple lathe alternatively by procuring a profile gringing machine. Since presently rolls are new and only a few rolls would be required on emergency basis, it is not recommened to procure special profile grinding m/c; however catalogue of one such machine is enclosed, ANNEX -I

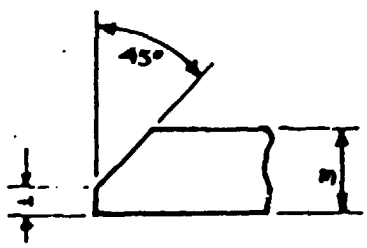
For local manufacture of rolls profile guages with side shoulder having same profile as that of rolls is required- sketch of one such profile guage has been drawn on page No. 16 .

Initially a round blank of following size is made:-

finished zize OD =+2mm.
" ID=-2 mm
" thickness+2mm.
" " Profile= +2mm.

SKETCH





BEVEL PROFILE EDGES

MARK CENTER LINE

MATERIAL : 3MM . THICK GAUGE PLATE

DRAWN NOT TO SCALE

S. C. ANAND.

Above operations can be done by shaper, ordinary lathe including maching rough profile by checking profile frequently by proposed profile guage.
Subsequently key way is cut roll sent for heat-treatment. After necessary heat treatment roll is ground to the required thickness on surface grinding m/c,I.D and O.D on lathe by fixing pneumatic/ electric grindling m/c on the tool post, and finally the profile with the same grinding attachment .(some skillis required by the operator to move the tool post simultaneausly forward and laterally)

Proposed heat-treatment cycle is as follows:-

i) Pre-heat roll to temperature 370°C and soaking time 2 hours.

ii)- Heat to temperature 650°C and soaking time 1 hour.

iii)- Raise further temperature to 940°C. Soaking time at top(heat treatment) Temp.:- 25 mts up to 20 mm wall thickness plus 8 mts for each additional 10 mm thickness.

iv)- Quench in oil (oil temp. preheated to 200°C) and then in air

v)- Tempering temp. 300°C for 2 hours.

Hardness achieved shall be as follows 58±2 RC.

SUMMARY OF RECOMMENDATIONS

1)- Tube mill rolls should be handled with care and never dropped from height.

2)- Rolls should never be kept on hard floor but on wooden planks /soft surface to avoid any breakage of edges.

3)- Rolls should never be heated localised beyond 450°C while removing from mill shafts to avoid formation of cracks and reduction of hardness.

4)- Rolls profile to be checked frequently by means of profile guage, incase of abnormal wear, its profile to be rectified to its original profile.

5)- Roll history log book to be maintained for each pipe and pass size.

6)- Essential rolls which wear out faster i.e. pass no.1 bottom and welding rools to be kept spare.

7)- Rolls to be manufactured indigenously.(roll's profile rectification process and manufacture of a new one is mostly identical).

SPARE MILL ROLLS REQUIRENT - WHICH PASS No.?

From the study of roll's profile as followed by M/S Voest-Alpine, it is observed that they have followed edge breaking/forming system and not centre forming system. It means side radious or lateral radious of stand No.1 is equal to the radious of curvature of welding rolls.

Radious of profile of rolls of pass No. 1 is most important and the same wears out faster since extreme bending of strip edges to the required welding radious is being done in the 1st pass itself. Hence these must be kept spare.

Secondly weld pressure rolls are working under extreme Heat and exerting pressure of forging the tubular shape edges; these are equally essential to be kept spare.

Presently, it isobserved, that pass No.2,3,4 profiling rolls, finrolls pass No 5,6 and 7, pressure rolls and welding rolls have been ordered. It is felt that, it is not essential to order at first instance pass No 2,3,4 and prewelding rolls.

Recommendations

i) Rolls procurement may be made on the following priorty:-

1st Priorty

- Pass No 1 Top and Bottom
- Welding rolls
- Top fin rolls rolls i.e.pass No 5,6 &7.

2nd Priorty

- Sizing driven rolls
- Turks head rolls

3rd Priorty

Balance Rolls.

ii) Profile rolls must be checked frequently by means of profile guage and worn out roller's profile reground- and not discarded.

MATERIAL FOR TUBE MILL ROLLS

Original tube mill rolls have been manufactured from material No. DIN 1.2080 which has following chemical composition (max.):-

C	Si	Mn	Cr
2.1	0.30	0.30	12.0

Subsequently tube mill rolls were ordered with material specification of original rolls i.e. DIN 1.2080 alternatively DIN 1.2379 , DIN 1.2379 has following chemical composition:-

C	Si	Mn	CR	Mo	V.
1.6	0.35	0.3	12.0	0.90	1.10

Out of above two materials, 2nd material is found to be superior, since apart for hardness and wear resistance, it is more tough(Due to the presence of Mo & V.)

Other materials recommened for rolls are as follows:-

i) Material No. DIN 1.2601

Chemical Composition:-

	C	Si	Mn	Cr.	V.	W.
Min %	1.56	0.25	0.2	11.0	0.1	0.4
Max.%	1.72	0.40	0.4	12.0	0.5	0.6

ii) BOHLER SPECIAL STEEL- GRADE KNL

Chemical Composition:-

C	Si	Cr.	Mo.	W.	V.
1.7	0.3	12	0.6	0.5	Traces

SUMMARY OF RECOMMENDATIONS

1. For Tube Mill Rolls, following either of materials may be selected.
   i) DIN. Material No. 1.2379
   ii) DIN. Material No. 1.2601
   iii) Bohler Special Steel :- KNL.

NOTE ON STRIP THICKNESS FOR PIPES TO SPEC. B.S. - 1387 (1985)

1. Thickness Tolerance

   Light= - 8%

   Med. & Heavy = -10%

2. Weight Tolerance

   Single Tube = +10% - 8%

   150 Meter & Larger=± 4%

Std.Thk	-4%	-8%	-10%	Recommened Strip Thickness
2	1.92	1.84	1.80	2
2.3	2.208	2.116	2.07	2.2
2.6	2.496	2.392	2.34	2.5
2.9	2.784	2.668	2.61	2.8
3.2	3.07	2.944	2.88	3.05
3.6	3.456	3.312	3.24	3.45
4.0	3.84	3.68	3.60	3.85
4.5	4.32	4.14	4.05	4.30
5.0	4.8	4.6	4.5	4.8
5.4	5.184	4.968	4.86	5.2

NOTE ON STRIP THICKNESS FOR A.S.T.M. PIPES

1. Thickness Tolerance

   All sizes and grades= - 12.5 %

   (same as given in table below)

2. Weight Tolerance

   i) Up to pipe size 4" (lot-truck load) = ± 10%

   ii) Above 4" pipe:-Individul pipe = ± 10%

Pipe Size Inch	STD Thk. m.m.	MIN. Thk m.m.	-10%	Recommened thk for A.S.T.M. Pipes	
				Galvanised	Black
½	2.77	2.41	2.493	2.4	2.5
3/4	2.87	2.51	2.583	2.5	2.6
1	3.38	2.95	3.042	2.9	3.0
1¼	3.56	3.10	3.204	3.1	3.2
1½	3.68	3.26	3.312	3.2	3.3
2	3.91	3.43	3.519	3.4	3.5
2½	5.16	4.52	4.644	4.55	4.65
3	5.49	4.8	4.941	4.8	5
4	6.02	5.26	5.418	5.25	5.4
5	6.55	5.74	5.895	5.75	5.9
6	7.11	6.22	6.399	6.25	6.4

NOTES

1. It is assummed that weights of pipes given in table x2.2 are both for galvanised pipes.
2. Zinc consumption for galvanising shall be varing from 10% to 3% depending on pipe size.
3. Wt. increase due to galvanizing shall be between 6% to 2% (higher for ½ pipes and lower for bigger pipes)
4. Present grade of steel being procured is OK; however minor change in the physical properties recummened is as follows:-

   Tensile Strength= 330 N/mm^2 min.

   inplace of 320 N/mm^2

   =Max. 450 N/mm^2

   Yield Strength = 205 N/mm^2 Min.

   inplace of 195 N/mm^2

Note on ASTM A-120 Specifications

1. Pipe thicknesses heigher than those of BS 1387 specifications.

2. Minimum thickness for pipe size 5" = 6.55 mm. and for 6" pipe = 7.11mm.

3. Outside diameter of pipe size 2½" and 6" different as compared to those of BS 1387 Spec.

4. Test pressure requirement up to 82 bar.

5. Zinc coating requirements are as follows:-

   Min. coating = 490 gms /sq. m.
   Average coating=550 gms/sq m.

6. Presently we can manufacture standardweight (Schedule 40) pipes of following sizes:-
   ½", 3/4", 1", 1½" and 2" N.B.

Comment on ASTM - A53 Pipes

Material

Sec. 4.3 - Weld seam of ERW grade "B" pipes shall be heat treated after welding so that no untempered martensite remains.

Nondestructive Electric Test

Sec. 11.1- The weld seam at each length of ERW pipes 2" and larger shall be tested with a non destructive test.

End Finish

Sec. 18.3- Toper- tapped coupling shall be provided on all weights of threaded pipes in size 2½" and larger.

- For standard weight pipes up to size 2" streight tapped coupling are provided however for extra strong and double extra strong taper thread couplings to be provided.

Notes

1- Specification has not made compulsory weld inside bead removal however if ultrasonic testing is used in place of eddy crunnet testing for the purpose of NDI, weld bead removal is must.

2- Pipe weight given in various tables are both for black and galvanized pipes.

3- With present equipment, we can manufacture flowing pipes sizes, thickness, but in grade A only:-

Pipes size N.B	thickness M.M	Schedule
½"	2.77 3.73	40 80
3/4"	2.87 3.91	40 80
1"	3.56	40
1¼"	3.68	40
1½"	4.05	40

4- Since material grade B, calls for weld seam annealing, we cannot produce the same at all. For installation of weld seam annealing equipment, couplete layout of tube mil and finishing equipment is required to be changed.

5- - Outside diameter of 2½ Pipes is 73 mm. in place of 76 mm. (of BS 1387
- Outside diameter of 6" pipes is 168.3 in place of166mm (of BS 1387)

Galvanising Plant Operations

Note on plant equipment

It has been observed that galvanising plant which has been supplied by M/S LECO of West Germany- along with its pretreatment section is simple however it has following short commings:-

1)- In pickling section no rocking arrangement has been provided

2)- Only one water rinsing bath has been provided after pickling

3)- No contineous flux filteration (bag /cloth pressure type) system provided.

4)- And the most important being that only 12° pipe extraction track provided inplace 14° extraction angle.

Above deficiencies give rise to the following problems:-

1.) Due to no rocking arrangement, while galvanising ½ and 3/4" pipes, pickling is not very efficient . To achieve the same. Pickling time has to be increased considerably- resulting in over pickling at places and heigher consumption of acid. Agitation of pipe bundle by E.O.T. crane is not sufficient to achieve the desired rocking action.

2.) One water rinsing tank is not sufficient for efficient rinsing and its ph value at times is found to be as low as 2.5, which is harmful for fluxing operation.

3.) The advantage of contineous flux filteration system avoids frequent flux iron precipition treatment. Since flux heating circulation system has already been provided, one flux filteration unit inline could have been easily provided without any extra piping & pump cost.

4.) Due to only 12° extraction angle it has been seen during plant operation that while galvanising ½" pipes, there has not been complete drainage of molten zinc from pipe inside- before the pipes are ejected to steam blowing station. Zinc drained out during extration, can be used back in the bath; which presently it is partly going along with the pipe and partly being collected as dust by steam eyclone.

In the present zinc tank of depth 1.6 meter, 14° extration angle can be provided without pipe lower end touching tank dross level.

Note on operational parameters

It is observed that plant by and large is being operated well- however since none of the existing persons have any past experience of "efficient" galvanizing operation; cost of galvanising is observed to be high.
Presentiy, control over pretreatment section, is being exercised very well but control over galvanising section requires improvement.
Successful and economical galvanising pertains to zinc bath where galvanising temperature, dipping time, extraction speed, steam blowing time etc are very very important.

i) Zinc bath temperature

Zinc bath temp. has been found well within control, however presently recorder was not found marking colour. Since the plant is operated in one or two shifts but bath temp. has to be maintained in all the three shifts; it is important that for better supervision / control of temp. in the night shift when no supervisor is present, recorded temperature would assist for control purposes. It was observed that top burner setting was being kept lower than of lower burners where as it should be the reverse. We need more heat on the top area of zinc bath where cold pipe is being dipped and also being extracted, where as at the bottom area, there is dross which is bad conductor of heat. In addition, total weight of zinc is exerting pressure on the bottom tank wall. For greater life of zinc bath it is recommened that top burner setting should be shightly heigher or equal to that of lower burner setting but never the reverse.

ii)-Dipping time

Dryer exit speed, starweel dipping speed and extraction speed should be so regulated that there are not more 5 to 6 pipes accumilation in bath for smaller dia. pipes and 2 for larger dia. pipes.(at the pipe extraction point) Presently more nos of pipes were observed which increase dipping time in the bath. It can be achieved by keeping record of PIV gear box pointer settings and rate of production.

iii)-Aluminium Alloy Addition

Aluminium content in zinc bath up to 0.007% increases its fluidity and retards zinc ash formation, in addition to giving shine to pipe outer surface. However larger quantity of Al content, gives rise to black spot problems inparticular for larger dia. pipes.

Based on experience it is recommened Al.content of 0.007% up to pipe size 1", 0.005% up to 2" pipe size and 0.002% for higher sizes.

Presently very high % of Al-alloy is being added in the bath. It is important to know from Al-alloy supplier, % of Al content in the alloy to decide its quantity to be added in the bath. Secondly, it should be added in small quantities i.e. for every ton of zinc added, alloy addition of 0.35 kg incase it contains 20% Al.Test of Al. content in bath:- Scatter a few crystals of ammonium chloride on the molten surface of zinc. Below 0.007 % aluminium content, above crystals move about freely but at heigher content they lie inert and are volatized.

iv) Pipe extraction speed

Pipe withdrawl rate should not be faster than the rate at which zinc drains freely from the inside pipe surface. Zinc drainage should be complete before pipe reaches inside blowing station- otherwise this free zinc is out in the form of dust inplace of drained zinc which can be collected and remelted/ used in the bath itself.

It is recommened not to have a withdrawn rate of more than 52 meter/mt and withdrawal speed marking to be marked on its PIV gear box.

V) Steam blowing

Presently there is no time setting available with the operational staff to set required steam blowing time.

Timer provided inside the electrical pannel also does not give clear time of blowing.

It is recommened that a 100 m.m. dia. syncronous timer to be provided outside the pannel to enable operational personnel to set it as per their requirement

Vi) Zinc quality

Electrolytic high grade zinc containing 99.9 % zinc and prime western zinc containing 98.5% zinc and balance lead, both may be used for galvanizing operations.

However, incase smaller pipe diameter (½ & 3/4") galvanising requirement is high, it is stronglyrecommened to use only electrolytic zinc since it has heigher fluidy and better drainage properties.(essentionally required for smaller dia. pipes)

vii) Use of locally available caustic soda for degreasing

Presently it is observed that special propriority degreasing compound is being procured for degreasing agent. Since caustic soda (sodium hydrozide) is availability within the country at nearly 1/5 th price of the imported degreasing agent and it would be equally effective, it is proposed to use locally available chemical.

viii) Recuperator for heat recovery from flue gasses

It is observed that exit flue gas temperature from the galvanising furnace is approx. 550 - 600°C. It is proposed to use a small recuperator to preheat air by the exit flue gases and use heated air at temp approx. 250°C for the combustion burners of galvanising furnace. It would result in saving of approx. 20% in fuel economy.

WHITE RUST FORMATION ON PIPES

Presently on most of the pipes of size ½" which were currently being galvanised, were observed to have white rust.

This attack is intensified by the presence of corrosive agents such as flux residues and acid vapours.

It is strongly recommened to quench pipes in solution of water containing sodium dichromate. Its percentage recommened is 0.2% , temp. should be maintained between 32°C to 60°C and dipping time of approx. 10 Sec. or more. It shall minimise formation of white rust.

Following would additionaly help in avoiding above problem:-

i)- Pretreatment section of galvanising deptt. should be provided partition wall between it and of pipe finishing deptt. minimising flux and acid fumes to come in the area of galvanised pipes.

Additionaly exhaust fume fans to be provided at roof of pretreatment section to achieve the above objective.

ii)- Incase pipes are given a dip in sodium dieromate solution, it is preferred to reduce Al. content in zinc bath bath to 0.001% for effective chromate film formation.

Experiments were conducted in the laboratory on ½" samples by immersing 2 pieces of pipes in 0.1% and two pieces in 0.2% sodium dichromate solution. Pipe samples with 0.2% dipping solution showed appreciable reduction of white rust formation

Cost Control in Galvanising

Zinc consumption is a major cost component in any galvanising process. Any savings effected in consumption of zinc without sacrificing quality standards will directly result in cost saving.

As described earlier, total coating is measured in terms of gms/sq. meter and coating thickness in the range of 350 to 400 gms/sq. m. (50-60 micron) meet major international standards . Heigher coatings are un-necessary and increase cost of galvanising.
From the production figures of galvanising sec. from March to Nov. 1989 (as given on page no. 31) zinc consumption analysis is as follows:-

Pipe tonnage Galvanised Tons	Total Surface area galvanised sq. meter	Zinc consumned Tons	Zinc consumption analysis	
			Kg/Ton	gms/sq.m.
2450	255226.6	220	86.6	861

International zinc consumption figures of efficient galvanising plants to coating thickness of 400 gms /sq meter are between 700 to 750 gms/sq meter depending upon pipe size.
Since zinc consumption during the past 8 months consolidated is found to 861 gms/sq m, there is scope to reduce the same to 750 gms/sq m.

Recovery of By-Products/Residues

In hot dip pipe galvanising process, by-products namely dross, ash and zinc dust are formned. In pipe galvanising, these account for nearly 40% of total zinc consumption. Percentage of each of the above in standard pipe plants is in the following range:-

Zinc Consumption	By-Products			Zinc on Pipe
100	35-40			
	Dross	Ash	Dust	60 - 65
	8-9	16-18	14-16	

PRODUCTION OF GALVANISED PIPES

(March- November 1989)

Pipe Size Inch.	Series	No of Pipes produced	Surface area/pipe Sq. meter	Total Surface area galvanised
½	L	71627	0.72	52088.9
	M	25640	0.704	18066.35
¾	L	28569	0.926	26481.4
	M	35714	0.91	32700.6
1	L	32379	1.17	37943.3
	M	5655	1.14	6498.95
1¼	L	10893	1.499	16335.8
	M	5829	1.47	8609.75
1½	L	6833	1.71	11689
	M	2631	1.699	4471
2	L	5664	2.16	12234.25
	M	2902	2.13	6199.99
	(1.6)	6850	2.28	15655.97
2½	L	1094	2.765	3025.68
3	L	992	3.25	3225.76

Total Surface area = 255226.63 SQ. Meter

Total Pipe Tannage = 2540. Tons.

Quantity of by-products given above are nett zinc conent and not gross weight. However zinc content in by-products is normally of the following order:-

Dross - 95% Zinc
Ash - 70% Zinc
Dust/blowings - 90% Zinc

Efforts should be made to reduce dross and ash formation and increase in blowing collection which otherwise is blown off or goes along with the pipe inside surface. At Arabian Steel Pipe Company, approximate weight of by/ products has been as follows: (No record is maintained now)

Dross gross weight = 20 Tons
Ash = = = 75 Tons
Dust = = = 15 Tons

Since no data is available of actual zinc content in these, based on past practice of standard zinc content basis, their figures are analysed as follows:-

Nett weight of dross = 20x0.95 = 19 Tons.
Dross % to zinc consumption = 8.6%

Nett weight of Ash = 75x0.7 = 52.5 Tons
Ash % to zinc consimption= 23.86%

Total Zinc Consumption = 220 Tons.

Nett wight of Dust = 15x0.9 = 13.5 Tons
Dust % to zinc consumption = 6.1%

Above figures indicate that dross % is well within control. It is basically due to good control on pretreatment section.
Ash% is high. It is basically due to long plant idle hours. It can be minimised by covering the zinc bath with asbestos sheet during long idle periods and reduction of bath temp. to approx. 430-435°C during such period.
Zinc blowing % is rather low. It appears a lot of quantity is going in air or there is spillage. This can be reduced by modification of blowing box and by trial of reduction of R.P.M. of cyclone fan.

Monthly Zinc balance sheet for Control Purposes

It is proposed that every month a comparative statement be made on zinc and other costly inputs VS surface area and tonnage galvanised, format for control/calculation given on page no.

Weighment of by- products is also required for zinc balance purpose.
To know exact zinc pick up on pipe, existing laboratory to be provided with additional chemicals to perform stripping test to arrive at exact zinc coating rather than reading by elkometer which is currently being used.
[Consultant has given necessary procedures for conducting important tests of galvanising process i e stripping test for actual coating test, free acid test in flux and Al-content in zinc bath etc. Infact above tests are currently introduced now.]
It is proposed that every month or preferrably in between 2 drossings, zinc balance sheet be drawn to know the actual utilization of zinc i.e.on pipe, in dross, ash, blowings and to determine unaccounted zinc(which may have gone infact on the pipe itself).- Procedureof making balance sheet is given on page no. 35

MONTHLY TOTAL ZINC CONSUMPTION VS. PRODUCTION

Month	Production of galvanised pipes			total surface in Sq. meter	surface area per ton	total zinc consumption Ton.	zinc consumption	
	Pipe sizex Thk.	No.	Tonnes				Kg/Ton	gms/Sq meter

ZINC BALANCE SHEET

Pipes Galvanised Size	Tnk No.	Total Surface area-Sq.meter	Average Coating by stripping test-gm/sq meter	Total Wt. of zinc on pipe	Dross Wt. Gross	Dross Wt. Nett	Ash Wt. Gross	Ash Wt. Nett	Dust Wt. Gros	Dust Wt. N

Total Wt. of Zinc on pipe + nett Zinc in (dross+ash+dust)= Total Zinc consumption

Unaccountable Zinc = Actual Zinc used - calculated total Zinc consumption

= It is OK up to 2% of Zinc used, since it will be blown off at cyclone and not collected.

Summary of recommendations on equipment & plant operations

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1. Rocking arrangement to be provided at the pickling plant and pickling time of pipes to be decreased.
   Even under the present circumstances pickling time to be reduced and it should be related to acid concentration percentage.
2. Contineous flux filteration to be provided for flux tank.
3. Pipe extraction device angle must be increased to 14°.
4. Zinc bath recorder to be made fully operational
5. Top burner setting should be heigher or equal to that of lower burner setting
6. Pipe dipping time in zinc bath to be minimised and accumulation of pipes avoided.
7. Al content of zinc bath should not exceed 0.007%- which should be checked by sprinkling ammonium chloride crystals on bath surface.
8. Pipe extraction speed should never exceed 52 m/mt.
9. P.I.V. gear boxes should be set for different production rates.
10. Syncronous timer to be provided at the pannel for steam blowing time.
11. Electrolytic high grade zinc to be used for galvanizing.
12. Locally available caustic soda (sodium hydroxide) to be used for pipe degreasing inplace of imported costly chemical.
13. Use of recuperator for heat recovery from flue gases and use of preheated air for furnace combustion.
14. Galvanised pipes to be quenched in sloution of sodium dicromate (0.2%) to minimise formation of white rust.
15. Zinc by-products recovered to be weighed monthly.
16. Zinc stripping tests to be conducted at works daily frequently.
17. Monthly zinc balance sheet to be drawn.

QUALITY CONTROL AT WORKS

Introduction

Production commenced at plant only nearly seven months ago and presently there does not exist any separate department to look after quality control functions.

Presently assistance is being taken of Royal Scientific Society Amman, whose engineer visits plant once a month and takes strip and galvanised pipe samples for chemical /Physical analysis + Zinc coating tests.

For checking pretreatment chemicals of galvanising dept. a small chemical analysis laboratory is provided and its chemist reports to the factory manager.

Recommendation on Quality Control System

Pipes are produced of mill at high speeds of 40 to 60 meters per minute.The quality control system should be such that production of defectives could be controlled even if speeds are high.

It is important that required tests are conducted at fixed time interval, results of tests and their frequency recorded in appropriateformats. In case of any failure, the next test conducted after a short interval to enable to carry out necessary rectification without causing much rejection.

Recommened Quality Control System and Test details based on spec. B.S.1387/85

Raw Material

1)- Visual Inspection

Individual coils should be checked, during the process of slitting, at nearly six places across the length and width actual thickness and width. Its observations should be recorded on slitter production report (refer Page no.12). Steel defects i.e laminations, slag inclutions, folds etc. if any should also be noted in the same format and complaint lodged with the supplier.

ii)- Chemical composition and physical properties .

One coil per heat, check analysis should be conducted for chemical analysis and physical properties. Its test results recorded on format given on page No. 46 , and compared with those given on the original mill test certificates of supplier.

Tests at Tube-Mill

i)- Pipe outside diameter, length, thickness and visual examination of general workmanship should be done hourly.
(Pipe O.D should be checked by micrometer and not by vernier callipers. Ovality max. per missible ± 0.2 m.m.)

ii)- Bend test, flattening test and drift expansion test, depending upon pipe size, should be done twice per shift.

iii)- Tensile test and elongation % test one per day.

Its results should be recorded on physical testing report given on page No. 47, details of various test are given on page No 40
For ease of cutting pipe samples, one band saw m/c near the roller conveyor to be provided. For conducting flattening test and drift expansion test, a simple column hydraulic press to be procu-red.
In addition one pipe bending machine having formers with radious of bend six times the outside diameter of different pipes up to 2", and to be installed near the pipe cutting machine.

Leak Tightness Test (Hydraulic Test)

Each tube to be hydraulically tested for internal pressure of 50bars, alternatively an eddy current tester to be procured.
It is observed that present production capacity of hydraulic testing machine is much lower than that of mill. The advantage of testing by eddy current tester is that it can be installed in line with tube mill and it tests pipes at the max. speed of 120 m./MT. In addition, for export of pipes to USA to ASTM spec. A-53, this test is a must .
Result of test to be recorded in the hydraulic test Production cum inspection report from given on page No. 48

Threading Tests

Pipe threaded ends must be checked for the total threaded length, gauge diameter, guage plane and quality of threads visually and by " Ring Guage ". (Since presently their are no ring guages, these should be procured to spec. B.S.21 System B). The present reporting format of production to be continued for quality control as well.
Frequency of Test:- Once every hour or earlier incase of chasers change.

Galvanising Dept.

All pipes coming out of galvanising plant should be checked for the following:-

i)- Visual inspection for black spot frequency and surface defects 100%

ii)-Weight of Zinc coating 4 times / shift

iii)- Uniformity of Zinc coating One/shift

iv) Adhesion of Zinc coating One / shift

v)- Free bore test Random

Presently only visual examination of pipes is being done alright and weight of Zinc coating checked at random by Elkometer plus one or two samples per month by Royal Scientific Society results of which are received very late- as a result production parameters cannot be amended suitably.

Results of pipes passed, rejected or to be regalvanised to be recorded in form given on page No. 49 and weight of coating by stripping test on form on page No. 50

For adhesion of zinc coating test, pipes require being round a former having radious of bend equal to 8 times the pipe diameter up to Pipe size 2". It calls for procurement of pipe bending machine and to be installed in galvanising dept. Details of tests to be conducted are given on page No. 42 .By conducting above tests, control over zinc consumption shall automatically be exersized.

Marking

All tubes above 4 meter in length should be marked with colour of desired colour prescribed about 50 mm.wide near each end of tube (Unlike one colour band being given now)

Pipe Test Certificate

Company should issue a manufacturer's work's test certificate to customers- a format of which is given on page No 52

Details of Test requirement (Brief text from BS-1387 Spec.)

Raw Material

The tubes and couplings to be made from steel coumplying with the following requirements:

Max.%				Tensile Strength N/Sq. mm.	Elongation % Min. on Guage Length $5.65\sqrt{So}$
C	Mn	S	P	320 - 460	20
0.2	1.2	0.045	0.045		

Thickness Tolerance

Light - 8%
+ Not limited
Medium & Heavy - 10%
+ Not Limited.

Weight

On single tube $\pm 10\%$
Over 150 m length $\pm 4\%$

Bend Test

Bending test on tubes up to and including 2 in (50 mm) nominal bore. The finished tubes shall be capable of withstanding the following bending test without showings of fracturs of weld.

The test shall be carried out by means of a tube bending machine round a grooved former of the radius specified, welded tubes shall be bend with the weld at 90° to the plane of bending. The tubes shall not be filled in this test.

Ungalvanised tubes shall be capable of being bent cold, without cracking, through 180° round a former having a radius at the bottom of the groove equal to six times the outside diameter of the tubes.

Flattening Test

Rings, not less 1½ in (38 mm) in length out from the ends of selected tubes, shall be flattened between parallel plates with the weld at 90° (point of maximum bending). No opening shall occur by fracture in a weld until the distance between the plates is less than 75% of the original outside diameter of the tube and no cracks or breaks in the metal elsewhere than in a weld shall occur until the distance between the plates is less than 60% of the original outside diameter.
The test rings may have their inner and outer edges rounded.

Drift Expension Test

A piece of tube approximately 4 in (100 mm) long cut from one end, shall be expanded cold, by means of a conical drift having an included angle of 40°-60°, until the internal diameter of the tube at the mouth has been increased by not less than 10%. Belling of the tube by spining methods is not permissible. The tube shall show no sign of crack or flaw as a result of this test.

Hydraulic Test - Leak Tightness Test

Each tube shall be tested for leak tightness at the manufacturer's works. At the option of the manufacturer, this test shall be either a hydraulic test at a pressure of 50 bar, the pressure being maintained sufficiently long for proof of inspection, or a non-destructive test which ensures equivalent leak tightness.

Any tube failing the leak tightness test shall be deemed not to comply with the standard.

DETAILS OF TESTS FOR GALVANISED PIPES

Visual Inspection

The Zinc coating should be uniform, tightly adherent and free from black spots.

Adhesion of Zinc Coating (Bend Test)

For pipe sizes up to 50 mm (2 in.), this test is done by performing bend test. A sample is bend cold through 90° around a former having radious at the bottom of the groove equal to 8 times the pipe outside diameter, without showing any crack in the coating.

Hammer Test

For pipe sizes 2 in. and above, a pivoted hammer of 200 grame weight shall be allowed to fall from 300 mm head, spacing between subsequent falls shall be 6 mm. No zinc should peel off during this process.

Free Bore Test

The test is for tubes up to 25 mm (1 in.) only. A rod 230 mm long and of following dia. shall pass through the pipe to ensure free bore.

Pipe Dia. N.B	Dia. of Rod M.M
½	9.5
3/4	14.3
1	20.6

Stripping Test: Please see next page .

Preece Test : = = = =

Stripping Test: Stripping test is considered by far the most accurate method and in fact it is included in all the specifications. It is universally acknowledged as a referee test in case of disputes.

PROCEDURE:-

The test is conducted as follows: 20 g of antimony trioxide or 32 g of antimony trichloride is dissolved in 1000 ml of concentrated hydrochloric acid (sp. gr.1.16). Before the test, the stripping solution is prepared by adding 5 ml of this solution to 100 ml of concentrated hydrochloric acid and mixed well. The test specimen is cleaned with solvent naphtha or trichloroethylene or any other suitable organic solvent, rinsed with alcohol, dried and weighed. The specimen is then stripped of the zinc coating by immersion in the test solution, the stripping of the coating being complete when evolution of gas ceases. Antimony chloride acts as an inhibitor and prevents etching of the steel during removal of the coating. After washing and drying , the specimen is weighed; the difference in weight before and after stripping divided by the surface area of the test specimen gives the weight of coating per unit area (g/m^2).

The temperature of the stripping solution shall at no time exceed 38°C. The same solution may be repeatedly used, without further addition of antimonychloride solution, until the time for stripping becomes inconveniently long. The time required for stripping will vary with the coating thickness, but should not exceed one minute, the number of specimens immersed at any one time shall not exceed three per 100 ml. of the solution.

Apparatus:- Balance, tong, beaker, fume extractor.

Calculation:- Surface area of sample=$A=\pi(D+ d)$ (length)

Weight of zinc coating gms/sq m = $\frac{W1-W2}{A} \times 10^{-6}$

Where W1=Wt. of sample in gms

W2= = = = = = after stripping

D=OD in m.m.

d= I.D in m.m.

l = length of sample in m.m.

Desired Frequency of Test:- 4 to 5 times in a shift.

Preece Test

Coating uniformity, the copper sulphate (Preece) test is concerned only with uniformity of a coating.

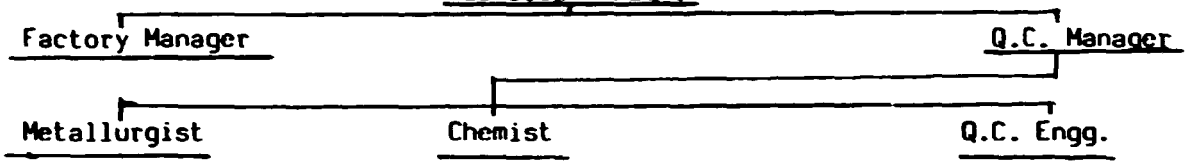
Samples to be preece tested are degreased with a suitable solvent (e.g. benzene and/or a systhetic detergent), wiped dry with a clean soft cloth, dipped in a 2% solution of sulphuric acid for 15 seconds, thoroughly rinsed in clean running water and wiped dry with a clean soft cloth.

The samples of length approx. 150 mm long are subjected to four successive dips in the copper sulphate solution, each lasting one minute. The solution has a specific gravity of 1.18°C(65°F) which requires approximately 76 g of crystalline copper sulphate ($CuSo_4$ $5H_2O$) disolved in each 100 ml of distilled water. The solution is shaken with an excess (about 1g/1 of solution) of copper carbonate or copper hydroxide, allowed stand for a day and then filtered or decanted.This neutralizes the solution. In each test the volume used in millilitres must be numerically at least 50 times the approximate surface area in square inches of the immersed portion of the articles being tested. Each batch of solution is only used once. After each of the four dips the samples are withdrawn, rinsed in clean running water and any black deposit removed with a fibre brush, care being taken to clean out all holes and pockets. The samples are then wiped dry with a clean soft cloth and except after the final dip returned immediately into the solution.The test solution is kept at 18° $\pm$ 2°C(65° $\pm$ 4°F).

If after testing, a red deposit of metallic copper appears on the samples, such a deposit may be tested for adherence either by peeling, light rubbing or by immersion in a solution of hydrochloric acid (1:10) for 15 seconds followed by immediate rinsing in clean running water with vigorous scrubbing. If the copper is removed and Zinc appears underneath the sample, it does not fail the test.

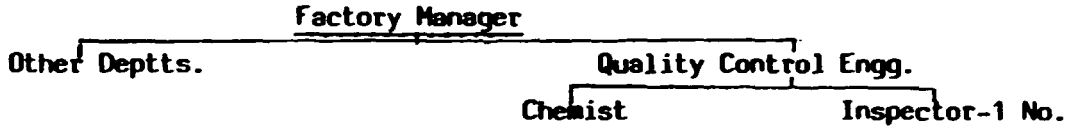
ORGANISATION STRUCTURE OF QUALITY CONTROL DEPT.

The ideal quality control dept. Organisation chart is given below:-



Functions:-	Chemical analysis of:-	Inspection of:-
- Product specifications	- Raw Material	- Finished product
- Process Control	- In process chemicals	- Stage inspection
- Physical, Mechanical and Metallografic testing	- In process laboratories	- Marking and product certification
		- Customer complaints and after sales service.

However since quality control deptt. has yet to be started, production operations commenced very recently and assistence of Royal Scientific Society . . . is being taken for metallurgical tests, organisation proposed is as followed:-



Inspection to be caried out at various stages of production-as recommend- can be performmed by the production foreman and the results documented in the proposed formats. Quality control Engg. in his shift, should get random tests done and countersign the test results; where as in the 2nd shift the same could be done by the quality control inspector.

Chemist shall be responsible for tests of pretreatment section of galvanising deptt. and galvanised coating tests etc.

Raw Material Testing Report

Date _____

No.	Coil Size thkxwidth	Supplier	Coil No.	Heat No.	Chemical Analysis					Physical Properties			Remarks
					C	Mn	S	P	Si	T.S., Kg/mm²	Yield Strength Kg/mm²	%age Elong.	

Chemist _____

Q.C. Engineer _____

TUBE MILL PHYSICAL TESTING REPORT

Pipe Size:.....

Thickness .....

Colour Indentification.....

Date:.....

Shift.....

TIME	DIMENSION (ALL in mm.)					PHYSICAL TEST			VISUAL INSPECTION			REMARKS
	OUTSIDE DIA			Length	Thickness	Flattening Test-above 2" pipe	Bend Test up to 2"	Drift Test	Height of Weld Bead INT	Height of Weld Bead EXT	Workmanship	
	X	Y	Z									
Standard Values												

Inspector.....

Mill Foreman.....

Deptt. Head.....

HYDRAULIC TEST REPORT

Date:.....

Shift:.....

Hydraulic Test Pressure 50 Kg/cm²

Tester No.....

Size & Series	No. of tubes Tested	No. of tubes failed	Percentage Failure	Identification colour and Monogram	Remarks

Causes of Failure:

INSPECTOR

Quality Control Engineer

Galvanising Production/Inspection Report

Shift .....

Date .....

Size & Series	Good Tubes	Bend Tubes	Complete Rejects	Total	Tubes for Regalvanizing	
					Re-galvanised in shift	To be Re-galvanised in next shif

TECHNICAL PARAMETERS

1. Zn bath. Temp:-
   (Hourly readings to be given)

2. Extraction Speed (m/MT)

3. Flue gas temp:-
   (Hourly readings to be given)

4. Quantity of Zn slabs used

5. Quantity of Al-Alloy used

Remarks: Reason of rejection

1 ._____

2. _____

3. _____

4. _____

INSPECTOR

QUALITY CONTROL ENGINEER

DATE.....

SHIFT.....

PIPE GALVANIZING TEST REPORT

DESCRIPTION		TIME	Wt.of Sample before Stripping (W1) Grms.	Wt.of sample after Stripping (W2) Grms.	Wt. of Zinc (W1-W2) Grms.	Wall THK. sample W2 (t) mm	ZN Coating= $\frac{W1-W2 \times 3930t}{W2}$	Free bore test up to 5 mm	Preece Test	Adhision Test bend/ Hammer	REMARKS
B Size	SERIES										

Inspector.....

Quality Central Eng. .....

Deptt. Head.....

WORKS TEST CERTIFICATE

Name of the Customer .....

Customer's order No.: .....

Pipe size ..... Quantity ..... Tone.....

Series and Thickness ..... Length .....

Pipes as per description given above have been produced and tested as per specification No..... These have withstood necessary prescribed tests and tubes confirm to the required specifications.

Quality Control Manager

Arabian Steel Pipe Mfg. Co. LTD.,

TRAINING ACTIVITIES

Formal training lectures on production technology for production of galvanised tubes, Raw Material qualities, quality control, plant maintenance, product diversification, tooling and on local manufacture of different spares were held. However due to paucity of time various subjects could not be discussed in detail.

Since presently except their General Manager, no other engineer has past experience of working in steel tube factory, it is proposed that four engineers are sent abroad for training in following areas:-

i)- One engineer on production technology of tubes

ii)- One engineer on pipe galvanising technology

iii)- One engineer on quality control of tubes

iV)- One engineer on General Mechanical Maintenance.

In addition one engineer from tube Industry with extensive experience in welded steel tube industry to be deputed for a period of nearly 6 months to train their engineers locally on their plant itself.

ACKNOWLEDGEMENTS

Expert on his behalf and on behalf of U.N I.D.O. Authorities acknowledge the cooperation and help extended by the following personnel to make necessary arrangements and to carry out the required study:-

1)- ARABIAN STEEL PIPES MFG. CO. LTD.,

1. Engg. Amin Shajrawi - General Manager
2. Engg. Musa Samir - Factory Manager
3. Mr. Iyad Jaradat - Administration Manager
4. Engg. Mohd. Ali Hussain - Mech. Maint. Engg.
5. Engg. Mohd. Abd- El Rahem - Galvanising Engg.
6. Engg. M.K. Shukri - Electrical Engg.
7. Mr. Richard Maroun - Mechanical Expert
8. Mr. Fares Ghanem - Tube Mill Foreman
9. Mr. Mohd. Shana'a - Chief of Accounts
10. Engg. Samir Jaradat - Marketing Officer
11. Mr. Amjad M. Allaf - Chemist
12. Mr. Samir Abdel Aziz - Executive Secretary
13. Mrs. Mayada Hijawi - Secretary

2- MININSTRY OF INDUSTRY

1. Mr. Usama Mufti - National Proj. Coordinator
2. Dr. Mohd. Bani Hani - Director and chief Proj. Co-ordinator

3- ROYAL SCIENTIFIC SOCIETY

1. Engg. K. Bahlwan
2. Dr. Azzam A. Odeh

4- U.N.D.P. STAFF AMMAN

1. Mr. Taoufik Ben Amara - Deputy Resident Representative
2. Mr. Adnan M. Naghaway - Programme Officer
3. Mr. Ahmad Ghadieh - Administrative Assist.

ANNEX I

Profil-Walzen-Schleifmaschine

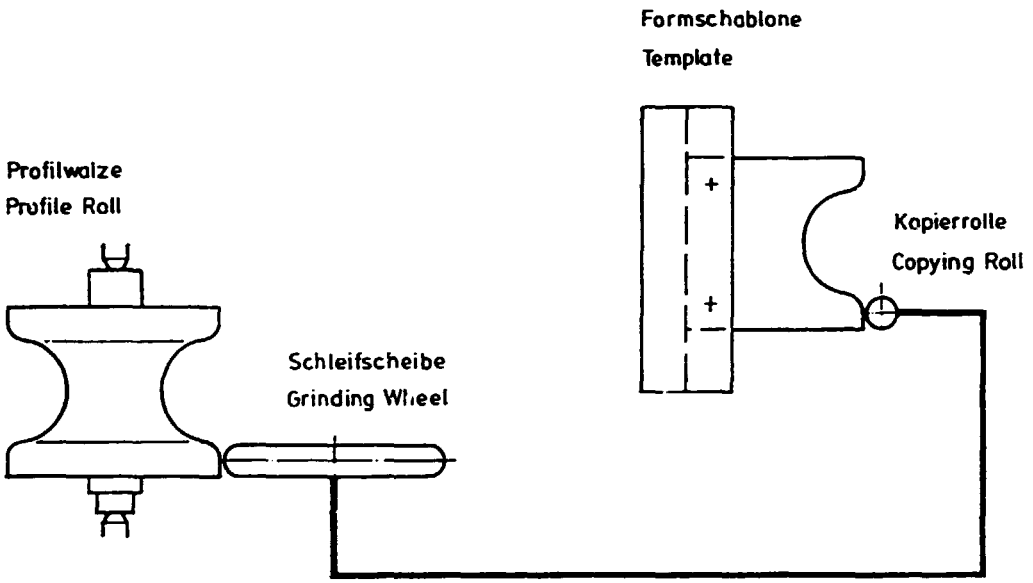
Die Profil-Walzen-Schleifmaschine arbeitet im Kopier-Schleifverfahren.

Das Arbeitsprinzip ist in der folgenden Skizze schematisch dargestellt:

Profile Roll Grinding Machine

We employ the copying system with our machine.

The operating principle is shown with the diagram below.



Die formschön, robust und schwingungsfrei – sozusagen aus einem Guß hergestellte Maschine – hat auf der linken Seite das Walzenaufnahmegehäuse, welches mit dem Maschinentisch bzw. -unterteil fest verbunden ist.

In diesem Gehäuse werden die zu bearbeitenden Walzen mit einem Aufnahmedorn zwischen den Drehspitzen aufgenommen und gespannt.

Die Drehspitzen sind in spielfreien Wälzlagern geführt. Die hintere Antriebsspitze mit Mitnehmer wird durch einen Zahnriemen von einem stufenlos regelbaren Getriebe (40–400 1/min) angetrieben.

Die vordere, mitlaufende Drehspitze kann in einem axialen Spannbereich von etwa 30 mm mit einem Handrad angestellt werden.

Um die Spitzen wölbt sich das Walzengehäuse in einem Abstand entsprechend dem größtem Werkstückradius.

Die Profilwalzen können von oben mit einem Hebezeug in das Walzengehäuse eingebracht werden. Zu diesem Zweck ist an der Oberseite des Walzengehäuses ein aufklappbarer Deckel vorhanden.

The compact streamlined robust one pipe casting and vibration free machine design carries on the l. h. side the roll housing, which is firmly connected with the machine bed.

In this housing the rolls to be machined are applied on an arbor and clamped between centres.

The centres are rotating in play free ball bearings. The rear drive centre is provided with a drive dog and driven via toothed belt by means of a infinitely variable gear drive (40–400 rpm/min.)

The front centre, which can be adjusted by handwheel in the axial direction within 30 mm range, is a live running centre.

The centres are in the roll housing, which has sufficient space to take the largest roll diameter.

The profile rolls may be lifted into the roller housing with the aid of a hoist or other lifting equipment, after opening the top folding cover of the housing.