

New CuNi 70/30 Flux Cored Electrode for Welding CuNi 90/10 Pipe

Final Report

Jack Devletian
Portland State University, Contractor
and
Mike Sullivan
NASSCO, Subcontractor

April 5, 2006

Outline

- Statement of the Problem
- Objective
- Collaboration of Four Teams
- Current Practice of Welding Cu-10Ni Pipe
- Major Accomplishments
- Conclusions

Statement of the Problem

- Poor Productivity in GTAW and GMAW-p of Cu-10Ni Pipe
- Metallurgical Issues
 - Prone to porosity and undercut
 - Solidification & Liquation cracking
 - Ductility dip cracking in HAZ of multi-pass welds

Objective

- Fabricate an all-position CuNi 70/30 Flux Cored Electrode (EN67T-1) to weld CuNi 90/10 Piping

Collaboration of Four Teams

- Portland State University
 - Contractor
 - Metallurgy and mechanical properties
- NASSCO
 - Subcontractor
 - Shipyard welding practice
- Stooddy and Cor-Met
 - Fabricators of Flux Cored Electrodes

Current Practice of Welding CuNi 90/10 Pipe

- GTAW:
 - RN67 filler
 - For all-position welding of pipe
- Pulsed GMAW:
 - EN67 electrodes
 - For flat position

Pipe Weld Joint by GTAW

(6 ½ inch Dia x 1/8 inch Wall)



Pipe Weld Joint by GMAW-p

(6 ½ inch Dia x 1/8 inch Wall)



All Project Deliverables Completed

- Literature Search:
 - Completed and published on NSRP website
- Final Report
 - Completed
 - Sent to ATI for publication in NSRP website
- Flux Cored Electrode
 - Developed and
 - Nearly ready for use in Naval ships

FCAW Parameters for EN67T-1

	A3	A5	A6
Voltage, V	20-23	20-25	20-25
Current, A	140-150	158	158
Wire Feed, ipm	310-320	310-320	310-320
Shielding gas	C25	C25	C25

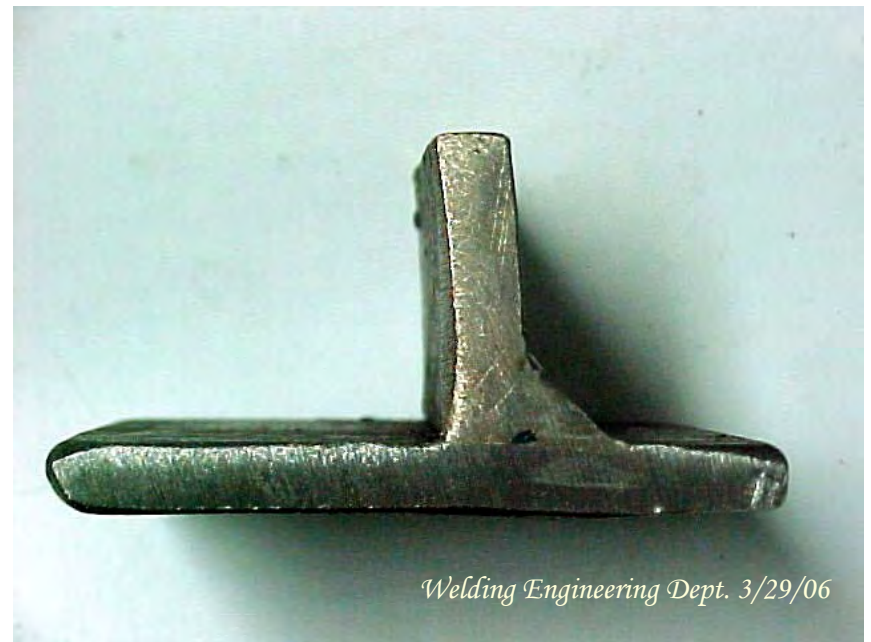
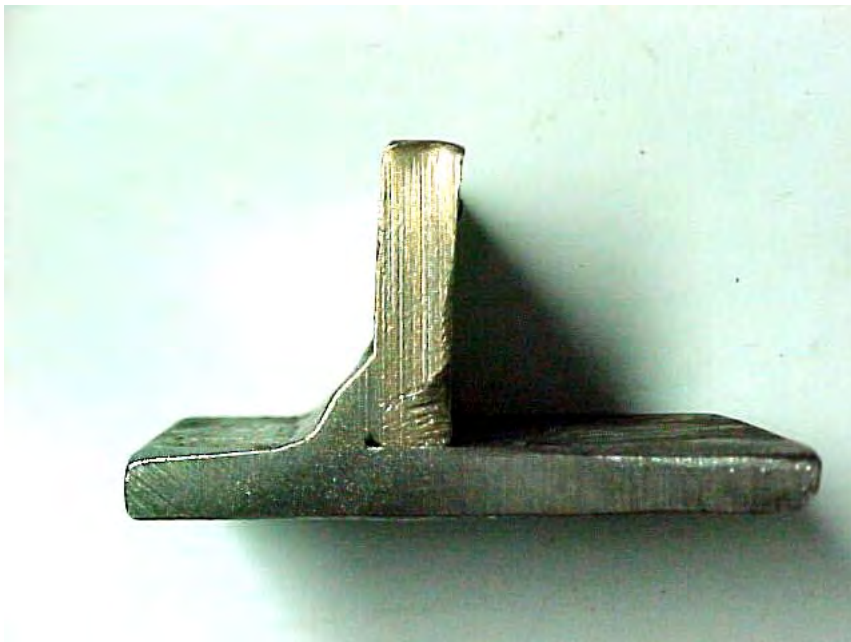
Vertical Position CuNi to CuNi



Vertical Position CuNi to CuNi



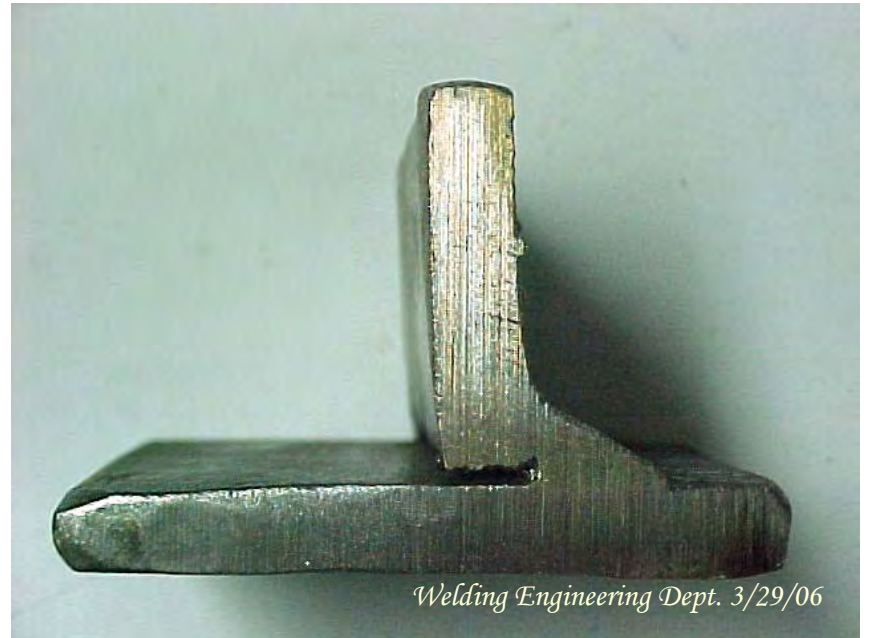
Vertical Position CuNi to Steel



Flat Position Pull / CuNi to CuNi



Flat Position Push CuNi to Steel



Flat Position Push CuNi



Flat Position Pull (Porosity) CuNi



Flat Position Pull CuNi (Porosity disappear after slight grind)



Vertical Position Downhand

CUNI



EN67T-1 Weld Metal Composition: Meet EN67 Requirements

Element	EN67 & RN67 MIL-E-21562E <u>Wire & Rod</u> GMAW & GTAW	A-3 (Stoody)	A-5 (Stoody)	A-6 (Stoody)
C	0.04max	<0.01	0.008	0.03
Mn	1.0max	0.5	0.68	1.00
Si	0.25max	0.1	0.12	0.30
Ni	29-32	32.1	32.39	32.6
Fe	0.4-0.7	0.80	0.81	0.80
Cu	Balance	Balance	Balance	Balance
Ti	0.2-0.5	0.10	0.10	0.40
P	0.020max	0.018	<0.005	0.020
S	0.015max	0.002	<0.001	<0.001
Total all others	0.50max	<0.8	0.12	0.16

Conclusions

- This project has proven feasibility to develop an all-position CuNi 70/30 flux cored electrode for welding of CuNi 90/10 piping.
- A suitable flux cored electrode can be developed for use with additional work.