- BRONZ1 TECHNICAL REPORT -

Lead-free brass alloy

NEXTBRASS®

Registered in ASTM, UNS No.C49355

(For hot working)

Rev. 2013.5.14

New Copper Alloy “NEXT BRASS”
Earth Friendly Materials - Lead Free Brass for Hot Forgings

In recent years, lead regulations have become strict gradually to reduce the amount of lead leachate from water facilities, and also have been discussed in the United States. President Obama has officially signed the bill for the application of the new standard NSF61 AnnexG in January 2011. This has enhanced to ensure that the lead controls of the parts related to water will become more strict from 2014 and will be amended to read that the content of lead for the pipes, fittings and drinking systems shall be “0.25% Max lead content weighted average of the products.” "NEXT BRASS" newly developed by us can satisfy these regulation and can keep you living in safe.

1. INTRODUCTION

NEXT BRASS has been developed with the concept “earth-friendly materials” and developed along the following three themes.

1.1 SAFETY

Lead Free & Corrosion Resistance

- NEXT BRASS is harmless for health because this alloy is lead free and has an excellent corrosion resistance.

1.2 ENVIRONMENT

Eco/Corrosion Resistance

- NEXT BRASS is lower cost materials than bronze for melting because the melting temperature is lower than bronze.
- Corrosion resistance is excellent and good for environment.

1.3 QUALITY

Cost-Down

- NEXT BRASS is lower cost than bronze.
- Saving electricity is available.

2. NEXT BRASS SERIES

2-1 Registration

NEXT BRASS has two types of use: for hot forgings and castings and this technical report explains for hot forgings.

NEXTBRASS has been acquired a patent in Japan and foreign and also has been registered in ASTM shown in Table 1.

Table.1 Registration

	Overview	Japanese Patent No.	ASTM
NEXT BRASS	Lead Free Brass for Hot Forgings	No.5143948	CDA UNS No.C49355

2-2 The Two Models of Extruded-Rod

NEXT BRASS for hot forgings has succeeded in developing a model number of two types in the chemical components of C49355 shown in Table2.

Table.2 The Two Models of Extruded Rod

Model	Characteristic	Forgeability
NEXT BRASS-E	Erosion-Corrosion Resistance, Dezincification Resistance.	◎
NEXT BRASS-SCC	Erosion-Corrosion Resistance, Dezincification Resistance, Stress-Corrosion-Crack Resistance.	○

3. TEST SPECIMENS

3-1 Chemical Composition

Chemical composition for NEXT BRASS is shown in Table 3

Table.3 Chemical Composition wt%

	Cu	Sn	Pb	Zn	Si	Bi
Min/Max. (C49355)	63.0 -69.0	0.5 -1.5	≦0.09	28.0 -35.0	0.5 -2.0	0.5 -1.5
NEXTBRASS-E	R	0.9	≦0.09	31.5	1.1	0.7
NEXTBRASS-SCC	R	1.0	≦0.09	28.2	1.6	0.7

3-2 Condition

The test bar coupon was made by extrusion with 500 ton pressing machine. The condition is shown in table 4. C37700 and C69300 made by extrusion bar and C89844 made by castings were used as comparative materials.

Table.4 Test Condition for Extrusion

Extrusion Ratio	21.1
Diameter of Billet	ϕ 150mm
Diameter of Extrusion	ϕ 32mm
Extrusion Temperature	700℃
Extrusion Rate	15.5mm/s

4. CORROSION RESISTANCE

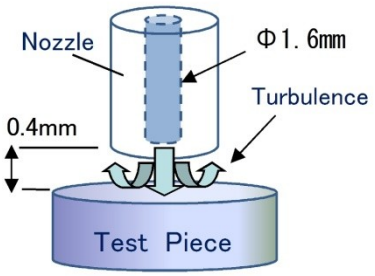
4.1 Erosion-Corrosion Resistance

Erosion-corrosion Resistance data is shown in Fig1 and 2. You can see that NEXT BRASS can provide an excellent erosion corrosion resistance by adding Sn.

Table.5 Erosion-Corrosion Test Condition

Reagent	$CuCl_2 \cdot 2H_2O$ 99%
Concentration	190g reagent in 15L dissolved water(1wt%)
Temperature	40℃±1℃
Flow Velocity	3.3m/sec
Flow Rate	400ml/min
Corrosion Time	5hours
Air Blown	2L/min

Test Model



* Photograph of Tested Sample *

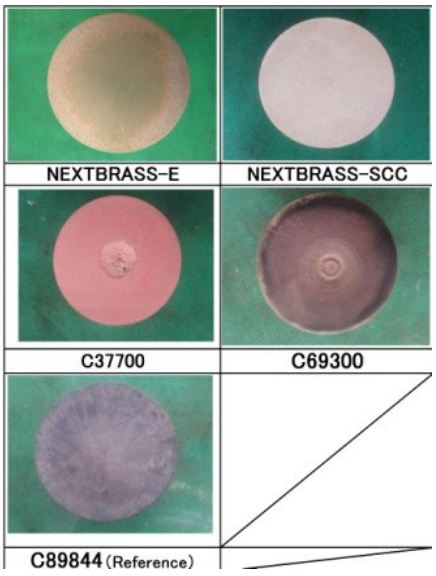


Fig1 Erosion-Corrosion Test (1)

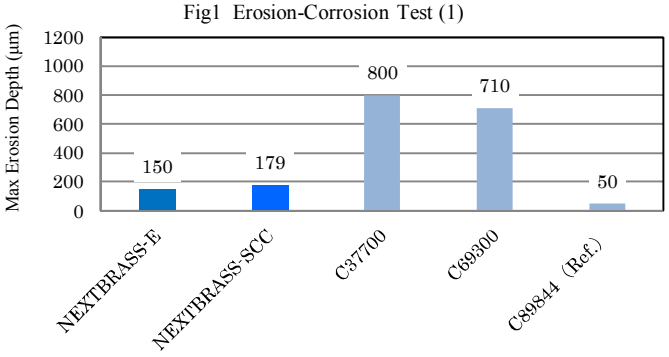
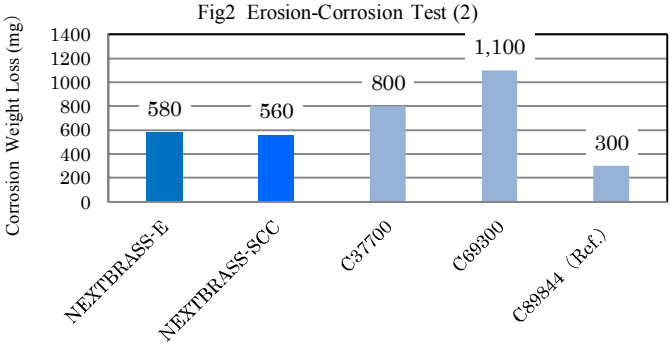


Fig2 Erosion-Corrosion Test (2)

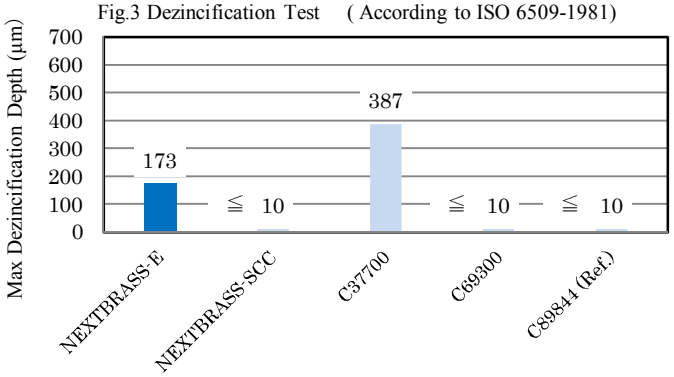


4.2 Dezincification Resistance

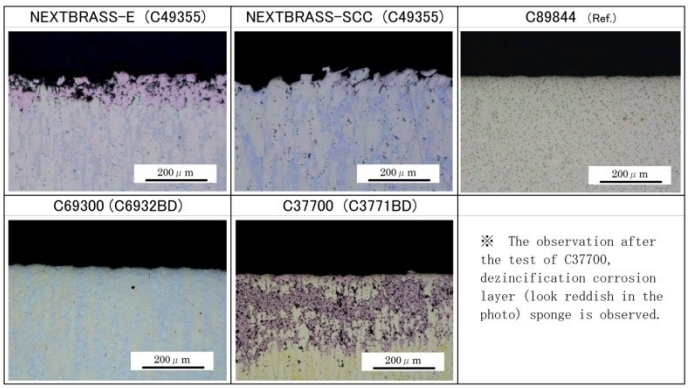
Dezincification of NEXT BRASS can provide an excellent dezincification resistance within 200 μm. (Fig 3)

※ EN Standards, Grade A ; 200μm or less

Fig.3 Dezincification Test (According to ISO 6509-1981)



* Photograph of Tested Sample *



4.3 Stress-Corrosion-Cracking

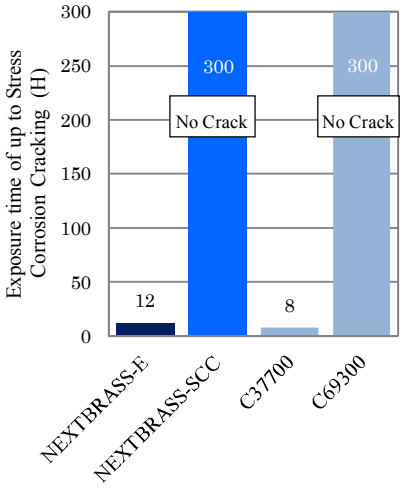
The taper screw combination is shown in Table 6. It's tighten constant torque and be exposed ammonia vapor atmosphere. Then we checked the presence or absence of cracks that is observed visually and microscopic at the specific time.

The test result is shown in Fig 4.

Table.6 Test Condition (Ref. ASTM B858)

Shape	ϕ 20.7×28mm-Rc3/8
Tightening torque	7.5 N・m
Atmosphere	Ammonia vapor atmosphere at room temperature (12%NH_3 Solution)
Photograph	
Criterion	The presence or absence of cracks that is observed visually or microscopic

Fig 4 Test Result of Stress Corrosion Cracking



5. HOT WORKABILITY

5.1 Hot Forgeability

NEXT BRASS maintains excellent hot workability by adding an appropriate amount of Silicon into Bismuth brass. The specimen was collected by extruding ϕ 80 billet to ϕ 22 bar with 100t hydraulic press machine.(Table7,8 and Fig5,6)

Table.7 Test Condition

Pressing Machine	110mm Crank Press
Specimen configuration	Diameter:20mm, Height:21mm
Upset Rate	≒60% Processing Rate = $(ha - hb)/ha \times 100$ *ha: Height before forging, hb: Height after forging.
Temperature	Measured for each material
Heating furnace	20 min
Evaluation Criteria	the temperature range of cracking does not occur by visual inspection

Fig.5 The processing method of hot forging

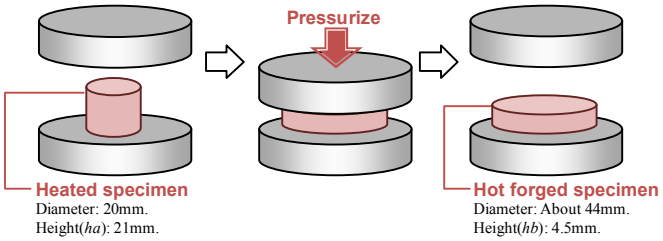
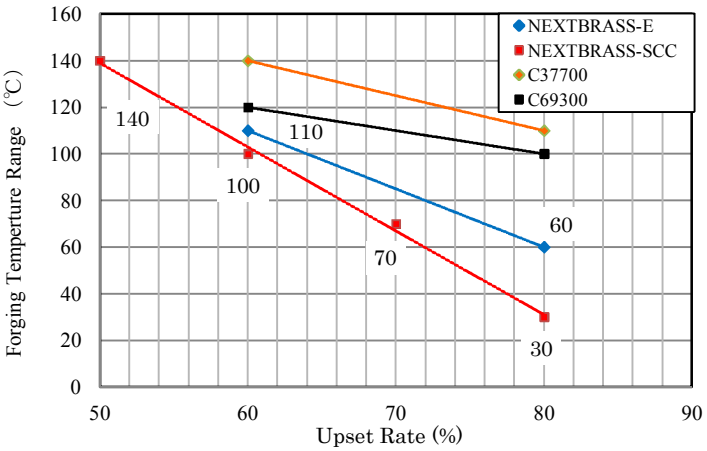


Table.8 Forging Test Result

Materials	Upset Rate (%)	Forging Temp. (℃)			Forging Temperature Range(℃)
		Min	Max	Nom	
NEXT BRASS-E	60	630	740	685	110
NEXTBRASS-SCC	60	660	760	710	100
C37000	60	550	690	620	140
C69300	60	580	700	640	120

Note: About forging temp, it has adopted the estimate value rather than actual measurement value.
Please refer as a comparative data.

Fig 6 Upset Rate －Forging Temperture Range



Note: NEXTBRASS-SCC suitable for low forging rate relatively.

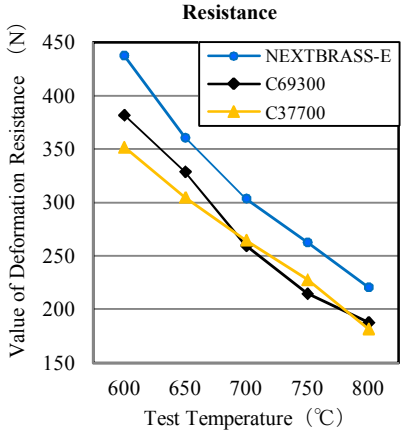
5.2 Deformation Resistance

Deformation resistance value of NEXTBRASS has drawn the curve value slightly higher than C37700. (Table 9, Fig 7)

Table 9 Measurement Condition

Machine	2000kN Servo Press
Measurement Method	By the Load Cell
Test Temp.	600℃～800℃
Compression Rate	80%
Compression Speed	40 spm

Fig 7 Measurement of Deformation Resistance



6. MECHANICAL PROPERTIES

6.1 Mechanical Properties

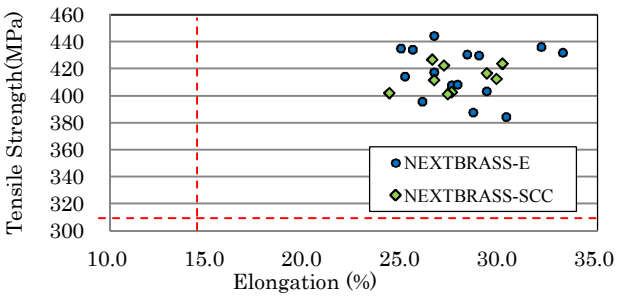
Mechanical properties of NEXT BRASS are excellent and superior to the JIS standard value of C3771 (C37700) as shown in Fig5, 6, 7 and Table10.

*JIS standard value of C3771
→ Tensile strength: 315MPa or more.
Elongation: 15% or more.

Table 10 Representative Value

Materials	Tensile Strength (MPa)	Elongation (%)	Hardness (HB 10/1000)
NEXBRASS-E	417	28	101
NEXTBRASS-SCC	412	27	110
C37700	456	32	119
C69300	603	30	126

Fig 8 Measured Values (Tensile Strength – Elongation)



6.2 Elevated-Temperature Tensile Properties

NEXTBRASS shows the same property as C37700 in high temperature tensile properties as shown in Fig 9, 10 and 11.

At room temperature when compared at 300℃, it keeps 100% of 0.2%yield Stress, 80% of tensile strength and 45% of Elongation.

Table 11 Test Condition of High Temperature Tensile Test

Machine	A Precision Universal Tester (AG-100kND)
Measurement Method	It examines after 10-minute maintenance to predetermined temperature
Test Temp.	100℃, 200℃, 300℃, 400℃
Temperature Error	± 2 ℃

Fig 9 Temperature – Tensile Strength

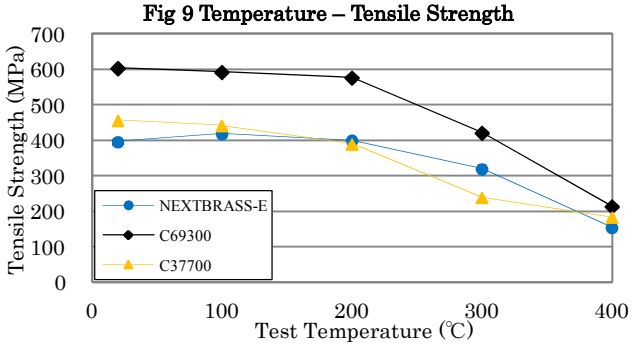


Fig 10 Temperature – Elongation

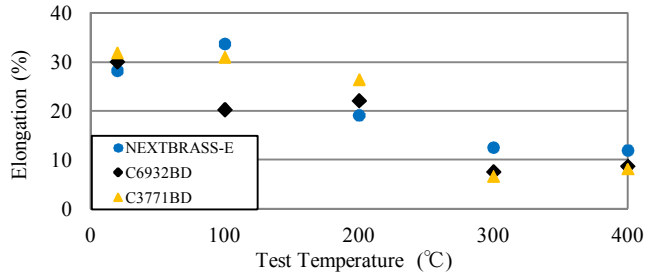
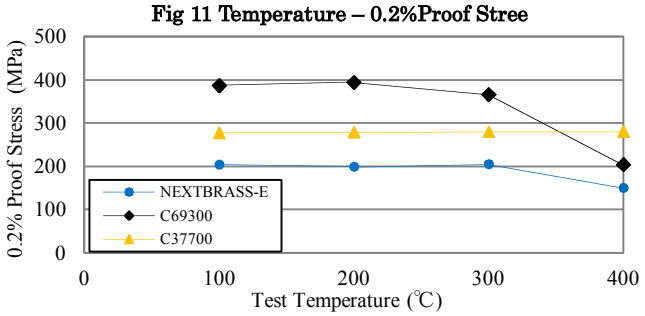


Fig 11 Temperature – 0.2%Proof Stree



7. MACHINABILITY

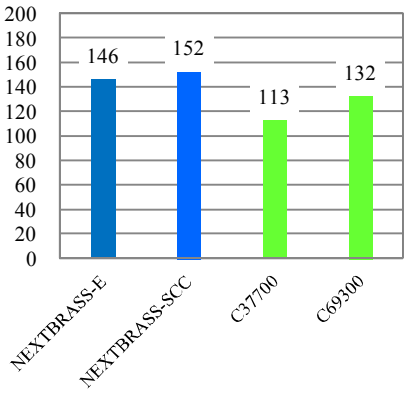
7.1 Measurement Value of Cutting Resistance

The cutting resistance value of NEXT BRASS when the contour cutting is shown in Fig 9. (Table 12)

Table.12 Test Condition

NC Lathe	The best search of setting of working condition by EGRO TNGG160404L-C
Chip	With coating
Cutting Speed	100m/min
Depth of Cut	1mm
Feed rate	0.1mm/rev
Repeated amount	10 times
Cutting oil	Non used

Fig12 Cutting Resultant Force(N)



7.2 Perforating by Drill

The test result of perforating by drill of NEXTBRASS is shown in Table 13, 14 and Fig 13, 14.

Table.13 Test Condition of Perforating

Test Method	Measure the time it perforation to 5mm
Machine	Drilling Machine
Number of Revolutions	510 rpm
Drill	OSG EX-SUS-GDS 5.0
Load	Two Levels (1.3kg,2.5kg)
Number of Repetitions	10 Times
Cutting State	Dry

Table.14 The Result of Perforating Test (Average)

< Average N=10 >	Load (kg)	Time of Perforating
NEXTBRASS-E	2.5	10.15
NEXTBRASS-SCC	2.5	8.97
C37700	2.5	4.45
C69300	2.5	7.63
NEXTBRASS-E	1.3	26.42
NEXTBRASS-SCC	1.3	25.82
C37700	1.3	13.76
C69300	1.3	Impossible

Fig 13 The Result Perforating Test (Load 2.5kg)

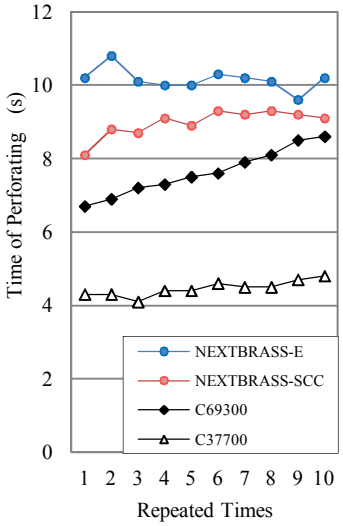
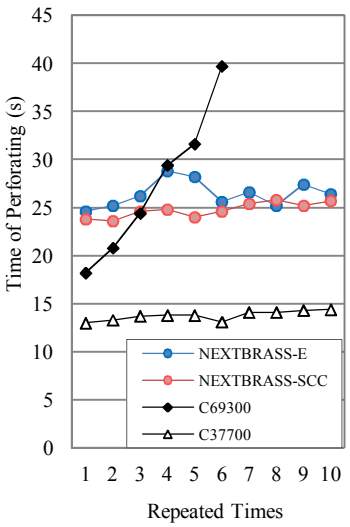


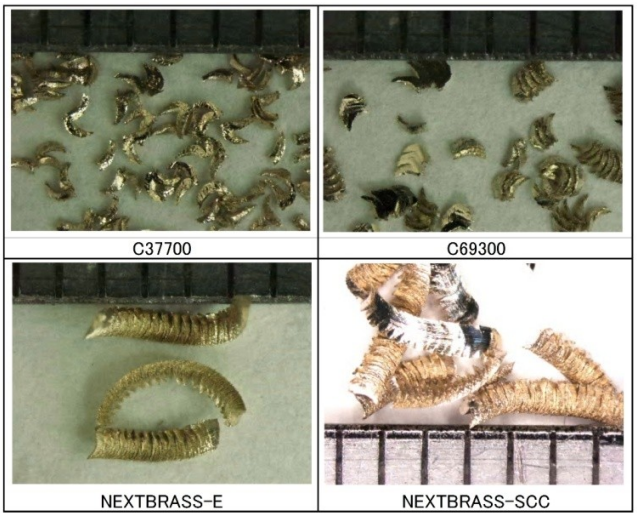
Fig 14 The Result Perforating Test (Load 1.3kg)



7.3 The Shapes of Chip

The photograph of chip is shown below. The chip of NEXTBRASS is divided by works of particle of bismuth and κ -phase as hard phase. (Fig 15)

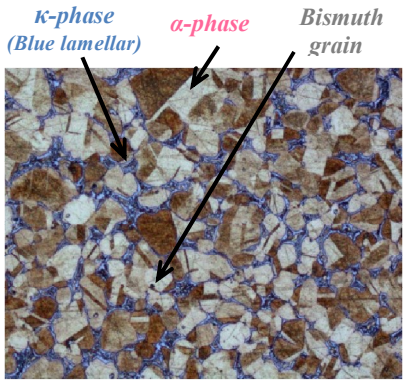
Fig 15 Photograph of Tested Samples



8. METALLOGRAPHIC STRUCTURE

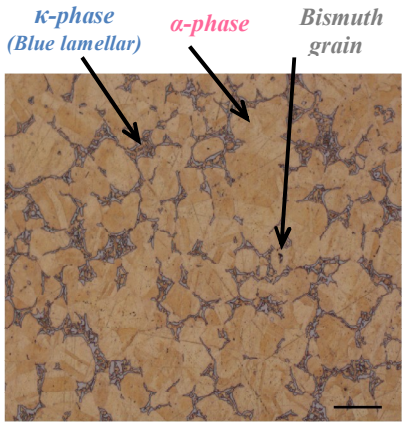
The metallographic structure of NEXT BRASS is shown in fig10. It is mainly composed with α-phase and κ-phase.

Fig. 16 Metallographic structure of NEXT BRASS-E



*optical microscope of 500 magnifications

Fig. 17 Metallographic structure of NEXT BRASS-SCC

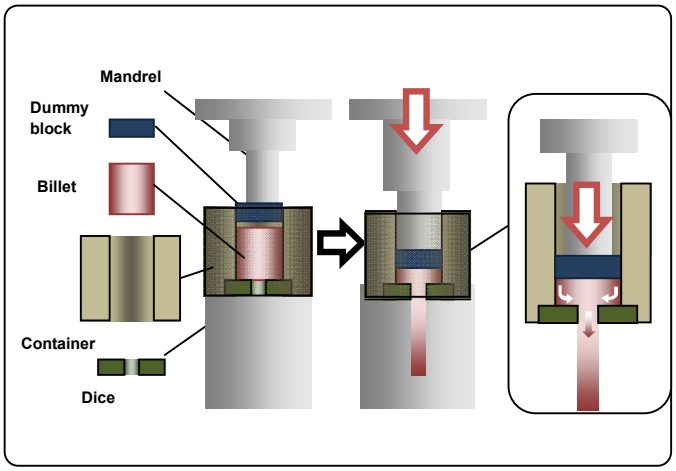


*optical microscope of 500 magnifications

9. SAMPLE EXTRUSION MODEL

Own test method of extruding is shown in Fig11.

Fig18 Processing of extruding by own test method



10. THE RESULT OF LEAD LEACHED TEST

Those of valve socket shape were made by forging and machining. The followings are the result of carried out the leaching test performance for water supply equipment by the Minister of Health, Labor and Welfare registration inspection body.

Method of Analysis ;JIS S3200-7 Water equipment- Leaching performance test method

Analysis items	*Analysis result (correction value)*	*Unit ; mg/L*
・Cadmium	0.0003 or less	
・Lead	0.001 or less	
・Zinc	0.22	
・Copper	0.01 or less	
・Bismuth	0.001 or less	

Notes;

(1)Without conditioning

(2)Method of analysis is according to Annex 1.
However Bismuth is according to ICP/MS method.

(3)The correction value of the analysis result is divided by 25 the concentration of leaching solution as feedwater tool installed in the piping

(Ref; Quote from the water supply database of the ministry of Health, Labor and Welfare)
Criteria in accordance with the leachate from water supply equipment as installed in except for the end of water supply equipment, or leachate from water supply pipe

・Cadmium	0.01 mg/L or less
・Lead	0.05 mg/L or less
・Zinc	1.0 mg/L or less
・Copper	1.0 mg/L or less
・Bismuth	No criteria