Properties of Antibacterial Additive (AM15) for Pottery

1. INTRODUCTION

AM15 is able to give an antibacterial function to pottery, such as sanitary ware, tile, tableware and enamel. AM15 is consisted of inorganic composition, including silver compound. Silver has an antibacterial effect essentially. It is called 'Oligodynamic Effect' , that is an action that very small quantity of metal ions have . The intensity of oligodynamic effect is shown as follows.

Hg > Ag > Cu > Zn > Fe > Pb > Bi

Mercury has a strong poisonous, then it is difficult to use. However, silver is en harmless for human and effective against bacteria. Silver nitrate solution was used for disinfecting of eyes formerly. Silver, itself is used for silverware, dental material, accessory and so on.

This report describes some properties of AM15 applied to pottery.

2. FEATURES

- AM15 is inorganic material containing silver compound for effective substance .
- AM15 is easy to apply to pottery, only mixing well to glaze at 0.5 0.5-3% .
- AM15 makes surface of pottery antibacterial.
- Antibacterial effect by AM15 indicates wide antibacterial spectra.
- Antibacterial effect by AM15 indicates excellent durability durability.

3.ANTIBACTERIAL EFFECT

Measurement of minimum inhibitory concentrations (MIC) was also carried out by Japan Food Research Laboratories (JFRL). Results are shown in Table 1. Society of Industrial Industrial-technology for Antibacterial Articles, Japan provides that antibacterial agent should have MIC ≦ 800 ppm against *Escherichia coli* and *Staphylococcus aureus* , respectively .

Table 1 Minimum inhibitory concentrations of AM15

Bacteria	MIC / ppm
Escherichia coli IFO 3972 (ATCC 8739)	200
Staphylococcus aureus IFO 12732 (ATCC 6538P)	200

4. AM15 PROCESS

AM15 is easy to apply to pottery. It is not necessary to prepare extra facility. Glaze slurry mixed with AM15 at 0.5 0.5-3% is glazed by flow coating or spraying or the like. An example of process is shown in Fig.1.

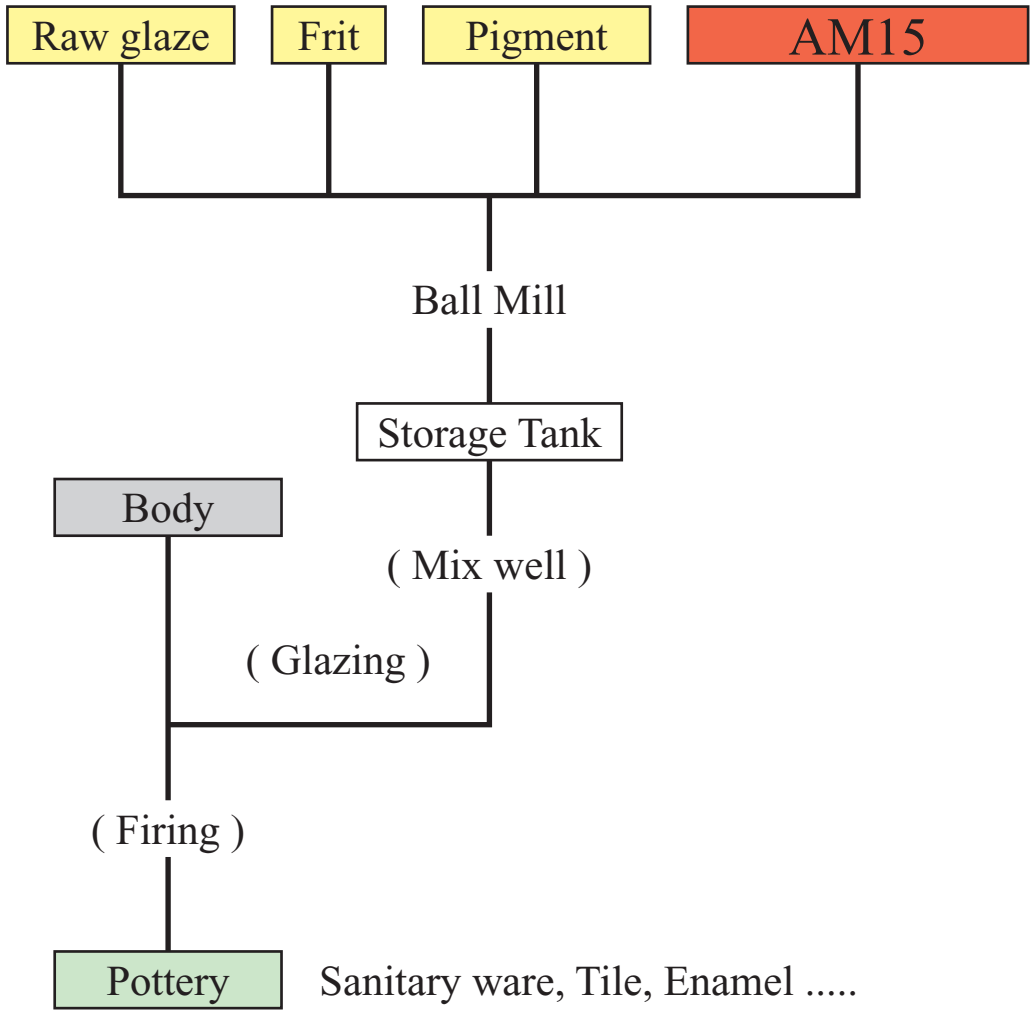


Fig.1 Process of pottery with AM15 for antibacterial

5. EVALUATION OF ANTIBACTERIAL EFFECT

Antibacterial activity of tile test samples treated with AM15 was evaluated by means of "Film Adherence Method". The test results are shown in Table 2.

The test method is authorized by the Society of Industrial-technology for Antibacterial Articles, Japan.

Table 2. Result of test according to Film Adherence Method

Test organism	Inoculation level*1) $N_{t=0}$/ cfu.*2)	Title Sample	Viable count test piece t=24hrs.*3)		Antibacterial activity value value*4)	Decreasing Rate Rate/%*5)
			$N_{t=24}$/ cfu.	$LogN_{t=24}$		
*E.coli**6)	1.1×10^5 $LogN_{t=0}=5.04$	blank	1.8×10^6	6.26	5.26	99.99<
		with AM15	<10	1.0		
*S.a**7)	2.0×10^5 $LogN_{t=0}=5.29$	blank	1.9×10^5	5.27	4.27	99.99<
		with AM15	<10	1.0		

*1) immediately after inoculation.

*2) cfu. means colony forming units

*3) incubated for 24hrs. at 35°C

*4) We get the antibacterial activity values by subtracting the $LogN_{t=24}$ value of treated sample from the blank value. The antibacterial activity value of antibacterial product is required to be not less than 2 in Japan.

*5) Decreasing rate is calculated by subtracting the $N_{t=24}$/cfu. of treated samples from the blank value. The decreasing value of the antibacterial products is required to be not less than 99% in Japan.

*6) *Escherichia coli* IFO 3972 (ATCC 8739)

*7) *Staphylococcus aures* IFO 12732 (ATCC 6538P)

6. DURABILITY AGAINST DETERGENT

In general, many kinds of chemicals and detergents are used for maintenance of pottery. Therefore, the durability of antibacterial effect against them was studied. The samples (tiles) were immersed in several chemicals and detergents such as acidic detergent, basic detergent, neutral detergent, surfactant, hypochlorite and hydrogen peroxide for 3 months. Also the sample was autoclaved (121 ^{o}C) twice . Untreated blank were not immersed in these chemicals or detergents. The results are shown in Table 3.

These results demonstrate the durability of antibacterial effect, but the surface of some samples became rough by immersing in these chemicals.

Table 3. The durability of antibacterial effect against chemicals and detergents

Sample	Viable count per test piece N_C / cfu. (untreated blank)	Viable count per test piece N_D / cfu. (treated samples)	Decreasing rate /% $\{N_C-N_D)/N_C\} \times 100$
10%HCl	8.9×10^7	$10^2>$	99.9<
10%NaOH	6.9×10^7	$10^2>$	99.9<
acidic	6.1×10^7	$10^2>$	99.9<
basic	4.4×10^7	$10^2>$	99.9<
neutral	4.2×10^7	$10^2>$	99.9<
surfactant	4.2×10^7	$10^2>$	99.9<
hypochlorite	4.4×10^7	$10^2>$	99.9<
hydrogen peroxide	6.3×10^7	$10^2>$	99.9<
autoclaved	1.5×10^6	10>	99.9<

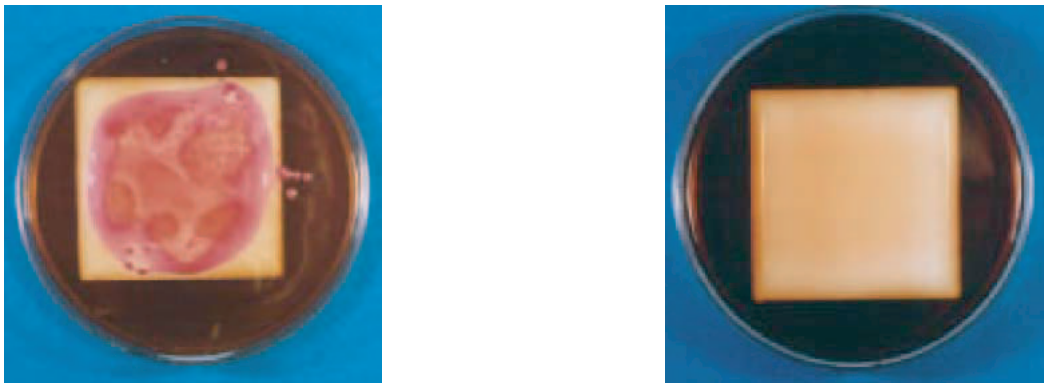
Test method ; Film Adherence Method

7. ANTIBACTERIAL EFFECT DETECTIVE METHOD

For public relations, it is necessary to make antibacterial effect visible. In this paragraph, one method is proposed. Some agar indicate color-developing according to the existence of bacteria. (See Fig.3 and Fig.4)

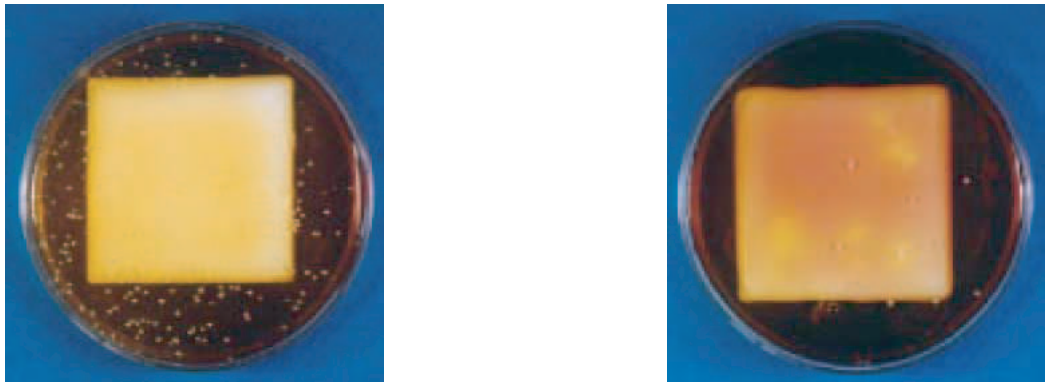
Method :

- Set sample in Petri dish (Instrument and samples should be sterilized).
- Inoculate bacterial liquid on sample uniformly.
- Incubate for 35°C/24 hrs..
- Pour dissolved agar* over the sample in the Petri dish carefully
  *_Escherichia coli_ : Desoxycholate agar
  *S_taphylococcus aureus_ : Mannitol salt agar
- Incubate for 35°C/20 hrs.
- Observe color-development* of agar, compare treated sample with untreated
  *_Escherichia coli_ : Color turns vivid red .
  *_Staphylococcus aureus_ : Color turns yellow .



untreated(blank) treated with AM15

Fig.2 Visible state of Escherichia coli using desoxycholate agar



untreated(blank) treated with AM15

Fig.3 Visible state of Staphylococcus aureus using mannitol salt agar