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ABSTRAK

TRIAL PRODUCTION OF EXAMINATION GLOVES FROM IRRADIATED NATURAL RUBBER LATEX IN FACTORY SCALE. The production irradiated latex by gamma rays from ^{60}Co at 20 kGy dose in the presence of 1 phr (part hundred ratio of rubber) of normal butyl acrylate (nBA) and 1 phr of carbon tetrachloride (CCl_4) in pilot scale has been done. A coagulation process for producing examination gloves in factory scale using the irradiated latex with various conditions of processing has been studied. The results show that irradiated latex can be used directly for producing examination gloves in factory scale. The gloves produced are easy to use for fine work without fatigue, and the quality meets to the Indonesian Industrial Standard (SII) or American Testing for Materials (ASTM) requirements.

ABSTRAK

UJI COBA PRODUKSI SARUNG TANGAN EKSAMEN DARI LATEX KARET ALAM IRADIASI DALAM SKALA PABRIK. Produksi lateks karet alam iradiasi dengan menggunakan sinar gamma Cobalt-60 pada dosis iradiasi 20 kGy, dan bahan pemeka CCl_4 1 psk (per seratus bagian berat karet), serta normal butil akrilat (nBA) 1 psk dalam skala pilot telah dikerjakan. Proses pembuatan sarung tangan eksamen skala pabrik dengan cara penggumpalan menggunakan lateks iradiasi serta beberapa kondisi yang mempengaruhinya telah dipelajari. Ternyata lateks karet alam iradiasi dapat digunakan langsung untuk produksi sarung tangan eksamen dalam skala pabrik. Sarung tangan eksamen yang dihasilkan halus, tidak menimbulkan rasa lelah selama dipakai, dan memenuhi persyaratan standar baik menurut Standar Industri Indonesia (SII), maupun Standar Amerika (ASTM).

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INTRODUCTION

The current world consumption of examination gloves is about 12 X 10^9 of which some 8 X 10^9 are used in USA. This product is therefore the largest single item, in tonage terms, made from natural rubber latex (1).

Development of rubber glove production using by radiation vulcanized natural rubber latex (RVNRL) or irradiated latex in the presence of 5 phr 2-ethyl acrylate and 1 phr carbon tetrachloride has been done. The combustion analysis of gloves from irradiated natural rubber latex showed that the amounts of gasses such as SO_x, NO_2, and ashes were less than those from the commercially available gloves (2).

This paper reports the results of trial production of examination gloves from irradiated latex in factory scale for preparation of commercial production in the near future.

EXPERIMENTAL

Material. Low ammonia type centrifuged NR latex from Cikumpai Rubber Plantation, PTP XII, Bandung, West Java, was used (Table 1). Carbon tetrachloride and normal butyl acrylate were used as sensitizer. Calcium nitrat was used as coagulant, and zinc diethyl dithio carbamate (ZDEC) as antioxidant. All the chemicals were technical grade without further purification.

Apparatus. Latex irradiator with activity 110 kCi ^{60}Co for producing irradiated latex, automatic dipping machine for examination gloves with capacity 7.000 gloves/hour, pH meter, viscometer, Instron tester type 1122 apparatus for measuring the quality of latex and its film were used in this trial.

Method. One hundred and fifty kg of natural rubber latex was pumped into a mixing tank (Figure 1), then mixed with rotation speed of around 25 rpm. During mixing, nBA and CCL_4 were added into the natural rubber latex. After mixing for 1 hour, the latex was pumped into a reaction vessel in the irradiation chamber and then irradiated at total dose of 20 kGy. The dose rate was measured using red perspex dosimeter. The average dose rate was : 1.51 kGy/h.

Antioxidant 0.5 phr of Nocract 300 was added to the irradiated latex. Examination gloves were made using an automatic dipping machine in a rubber gloves factory located at Bekasi, West Java. Ceramic formers and calcium nitrate as coagulant with various concentrations (8, 10, and 12%) were used for dipping into irradiated latex with various total solid (40, 45, and 50%). The detail procedure is explained in Figure 2. The physical and mechanical properties of the examination gloves were measured according to the specification of SII or ASTM (3, 4).

RESULTS AND DISCUSSION

Table 2 shows the effect of coagulant concentration on thickness and weight of examination gloves size 7 produced. It indicated that by increasing the concentration of calcium nitrate, the thickness and weight of examination gloves produced increase. It means that higher concentration of calcium nitrate attached to the surface of gloves former can adsorb more latex, so the thickness and weight of gloves increase. Also by increasing total solid content of irradiated latex, the thickness and weight of examination gloves increase. So, it is easy to understand that the thickness and weight of gloves are strongly related to the concentration of calcium nitrate and total solid content of irradiated latex. According to this data, for getting one peace of glove of 7 grams weight, the concentration of calcium nitrate used is 8% for total solid content of irradiated latex around 50%, and 10% calcium nitrate for 45% total solid content of irradiated latex.

The effect of storage time on the properties of irradiated latex and its film are shown in Table 3 and Figure 3. It indicates that by increasing storage time, the pH, viscosity and modulus 600% increase, while permanent set decreases. Tensile strength first increases then after 40 days decreases, while total solid content and elongation at break are quite the same. The increase of modulus and the decrease of permanent set may be due to the increase of entanglement among polyisoprene molecules.

The effect of heating temperature on tensile strength of gloves is shown in Figure 4. The tensile strength increase quite rapidly at the temperature up to 100° C and reaches about 25 MPa, but further heating shows no significant increase. The rapid increase in the tensile strength during heating is probably due to reduction in moisture content and better fusion of latex particles.

The effect of production rate on tensile strength of gloves is shown in Figure 5. It appears that by increasing the production rate, the tensile strength decreases, because leaching time becomes shorter. Sufficient leaching is needed to remove most of soluble hydrophylic materials present in the latex film, so that better adhesive of particles and chain entanglement of rubber molecules may occur. The electron micrograph of unleached film showed a rough and undulating cross-section with many spots whereas the leached film showed smooth and even surface (Figure 6).

Table 4 shows the specification of examination gloves from irradiated latex and specification from SII and ASTM.

Tensile strength and elongation at break before and after aging for examination gloves from irradiated latex are higher than those specified in SII or ASTM standards. So, it is reasonable to conclude that irradiated latex can be used for producing examination gloves.

Practical test of examination gloves from irradiated latex was carried out by workers at PAIR-BATAN, and the glove factory. The results show that gloves from irradiated latex are easy to use for long period. This is due to its lower modulus as compared with commercial examination gloves (Table 4).

CONCLUSION

Irradiated latex can be used directly to produce examination gloves in factory scale. The gloves produced can fulfil all requirements in SII ar ASTM standards. Gloves from irradiated latex are easy to use for fine work without fatique. Production of such gloves if expected to be commercialized in the near future in Indonesia.

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Table 1. Specification of natural rubber latex from Cikumpai rubber plantation, produced in September 1989

Parameter	Value
pH	9.28
Total solid content, %	62.21
Dry rubber content, %	60.53
Viscosity at 30^{o}C, Cp.	119.00
KOH number	0.78
Total NH_3, % weight of latex, %	0.28
Volatile Fatty Acid number	0.04
Mechanical Stability Time, sec.	790.00

Table 2. Thickness and weight of one glove produced from factory scale trial production using different concentrations of coagulant and total solid contents of latex

Total solid of irradiated latex, %	Concentration of $Ca(NO_3)_2$, %					
	8		10		12	
	t	w	t	w	t	w
40	0.09	6.0	0.10	6.5	0.13	7.1
45	0.10	6.5	0.16	7.2	0.19	7.9
50	0.19	7.0	0.20	8.0	0.22	9.0

t = thickness, mm.
w = weight, gram.
Production rate was 700 gloves/hour.
Size of gloves was 7.

Table 3. Effect of storage time on the properties of irradiated latex after mixing with antioxidant

Parameter	Storage time, day						
	0	3	5	10	20	30	60
pH	10.2	10.2	10.3	10.3	10.4	10.4	10.4
Total solid content, %	45.6	45.6	45.7	45.6	45.5	45.6	45.6
Viscosity, Cp.	9.0	10.0	11.5	12.2	12.9	13.4	15.9

Table 4. Specification of examination gloves from irradiated latex and ASTM of SII standard for examination gloves

Parameter		Irradiated latex gloves	ASTM	SII
Modulus 300%, MPa		0.9	–	2**
Tensile strength, MPa	A.	23	21	21
	B.	21	16*	16*
Elongation at break, %	A.	1000	700	700
	B.	990	500*	500*

A = before aging.
B = after aging at 70°C/166 hours or 100°C/22 hours.
* = minimum
** = maximum

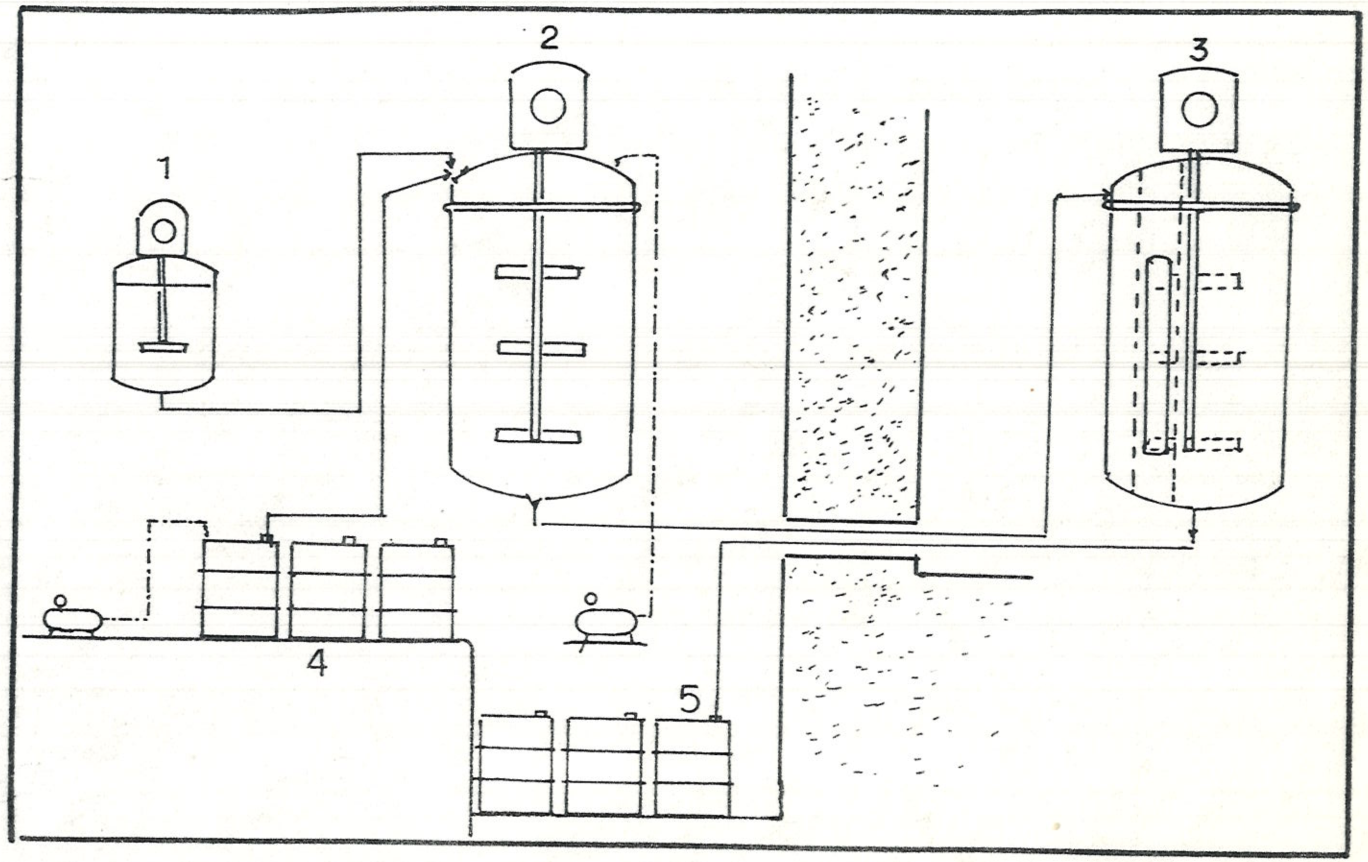

Figure 1. Schematic diagram of trial production of irradiated NR latex.

1. Emulsion tank　2. Mixing tank　3. Reaction vessel

4. Natural rubber latex (NRL).　5. Irradiated NRL.

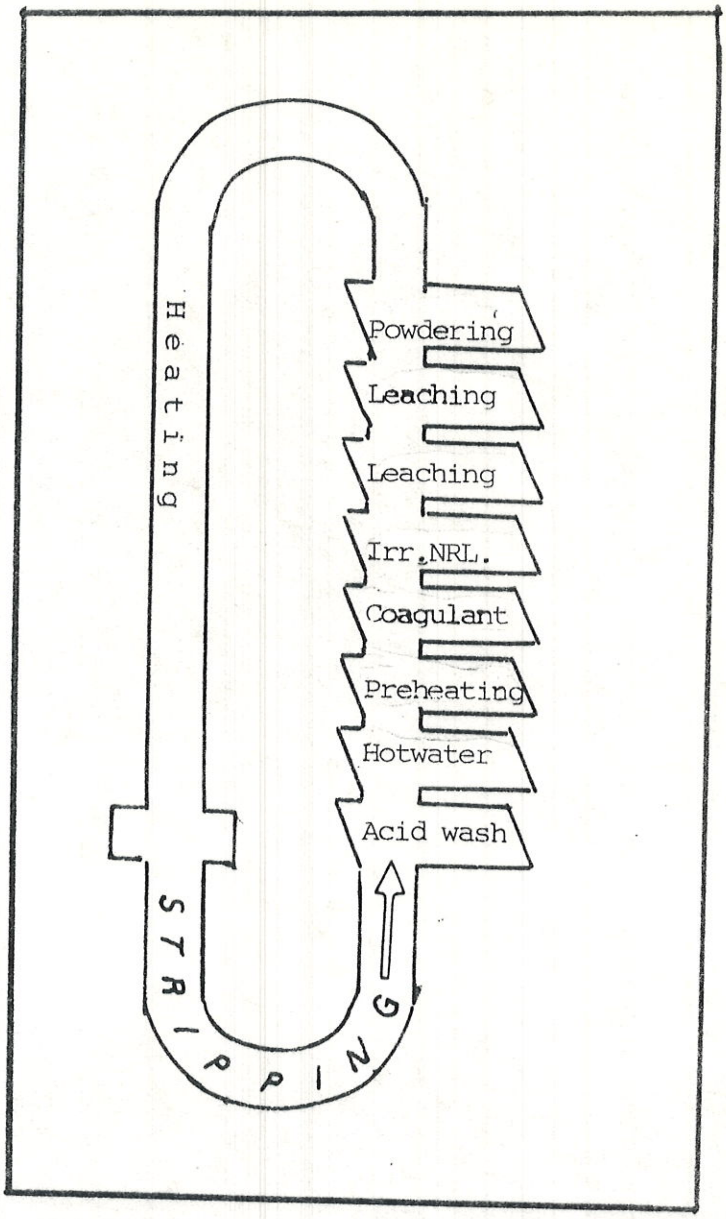

Figure 2. Production process of examination gloves from irradiated NRL.

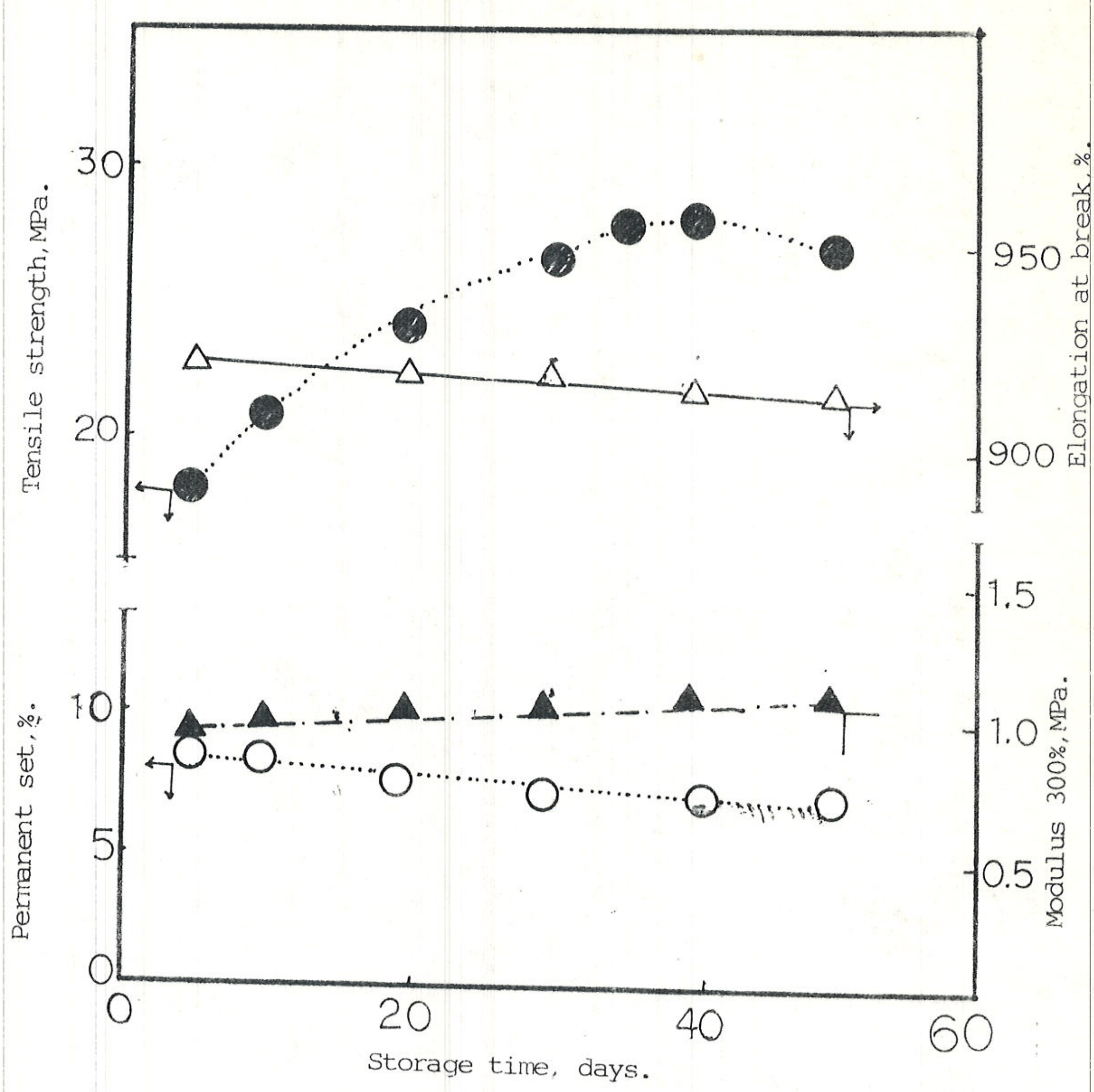

Figure 3. The effect of storage time on the physical and mechanical properties of examination gloves from irradiated NRL.

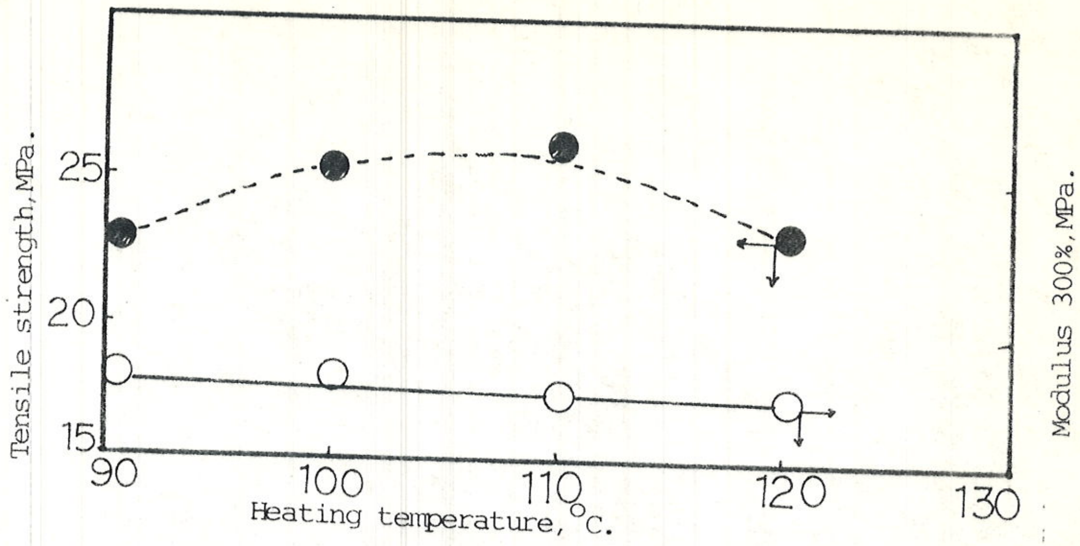

Figure 4. The effect of heating temperature during processing on tensile strength, and modulus 300%.

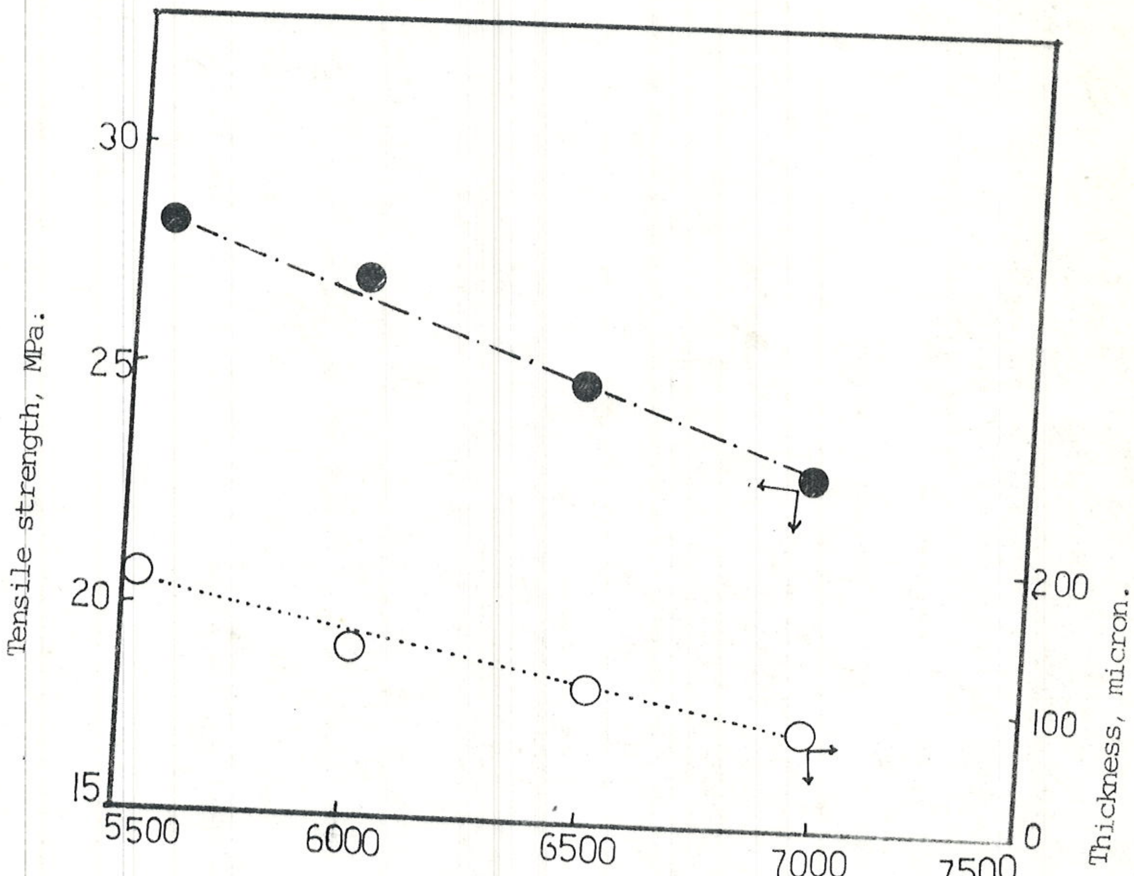

Figure 5. The effect of production rate on tensile strength and thickness of rubber examination gloves.

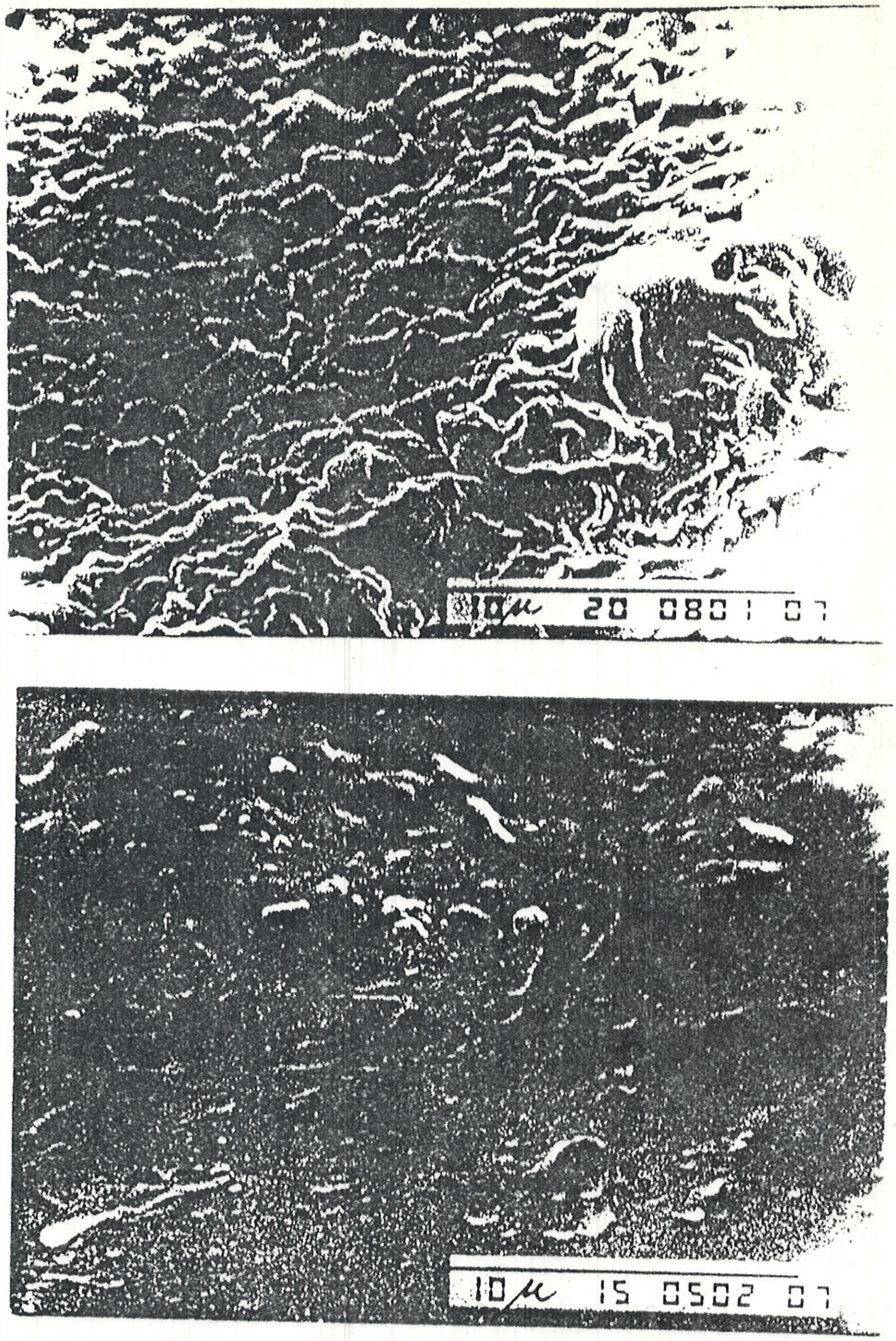

Figure 6. Electron micrograph of film from irradiated latex before (up), and after leaching (down).