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Downward melt drag twin roll caster

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A downward melt drag twin roll caster was devised for composite strip casting. A clad strip and a wire inserted strip can be cast using the downward melt drag twin roll caster. The downward melt drag twin roll caster is one of horizontal type twin roll caster, and a nozzle was attached to a upper roll. In the present study, fundamental features of the melt drag twin roll caster were shown. The relationship between casting conditions and the strip thickness was investigated.

1. INTRODUCTION

A twin roll caster has some advantages. For example, energy saving, process saving and rapid solidification. Therefore, roll casting of composite strip has some advantages, too. Large size laminate or wire-inserted composite strip can be cast only by the twin roll caster. This shows that number of the processes can be omitted. However, the clad strip was not cast using the twin roll caster. The reason is that the twin roll caster, hat is suitable for composite strip, has not been devised. A horizontal type twin roll caster, in order to cast composite strip, was devised, and properties of this caster were investigated in the present study. This horizontal type twin roll caster was named as a downward melt drag twin roll caster.

2. DOWNWARD MELTDRG TWIN ROLL CASTER

A conventional horizontal type twin roll caster is shown in Fig.1 (a). The downward melt drag twin roll caster (DMDTRC) is shown in Fig. 1(b). The twin roll caster for clad (laminate) strip is shown in Fig. 1(c), and the twin roll caster for wire-inserted strip is shown Fig. 1(d). When the clad strip was cast, another nozzle was attached to the lower roll. In the casting of the wire-inserted strip, the coil of the wire was attached below the nozzle. The tool in order to support the wire could be attached close to the roll gap. There is enough space to mount the wire-support below the nozzle. Therefore, wire could be inserted the roll gap easily. It is clear that the casting of clad strip or the wire-inserted composite strip is difficult using the conventional twin roll caster.

In the conventional twin roll caster, a nozzle was set between the nozzles. In the downward melt drag twin roll caster, the nozzle was attached to an upper roll. A channel was made at surface of the nozzle contacts to the roll. This channel was called as a slope (ref. Fig.2). Solidification layer and molten metal was dragged from the slope by the upper roll. Quantity of molten metal was controlled by the gap of the slope. The quantity of the metal dragged from the nozzle became larger as the gap of the slope became wider. A puddle of the melt was formed on the lower roll. The puddle became larger as the melt dragged from the nozzle became larger. The solidification layer was formed in the puddle. The solidification layer became thicker as the puddle became thicker. The upper roll was inclined to the lower roll at 11 degrees in order to hold the puddle without flowing down from the lower roll (ref. Fig.3).

Table 1 Experimental conditions

Roll	φ250×100 mm
Roll speed	10□40 m/min
Specimen	A1050
Slope length	20,40,50 mm
Slope gap	1.8, 2.1, 2,4, 2.9 mm
Melt temperature	680 □
Roll position	11 degrees

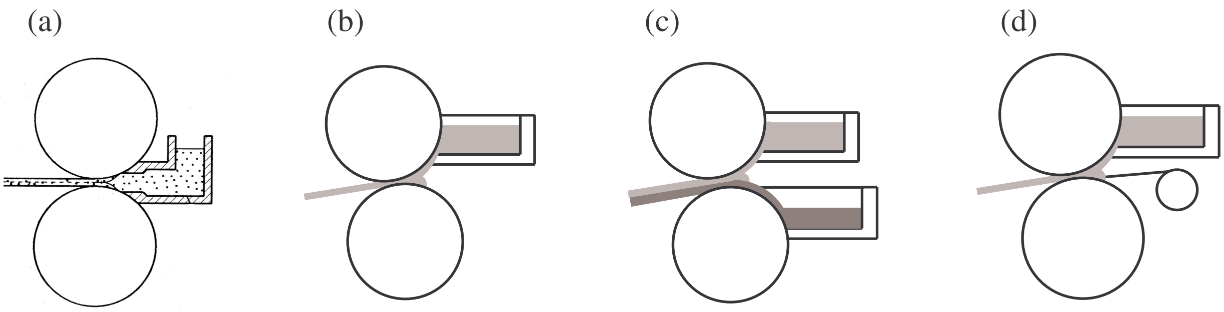


Fig. 1 Schematic illustration of twin roll casters for strips and composite strips (a)conventional, (b)downward melt drag twin roll caster, (c)downward melt drag twin roll caster for a clad strip, (d)downward melt drag twin roll caster for wire inserted composite strip

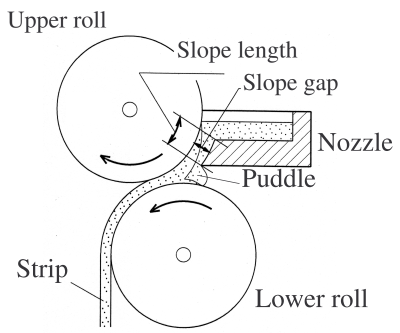


Fig. 2 Schematic illustration of a downward melt drag twin roll caster

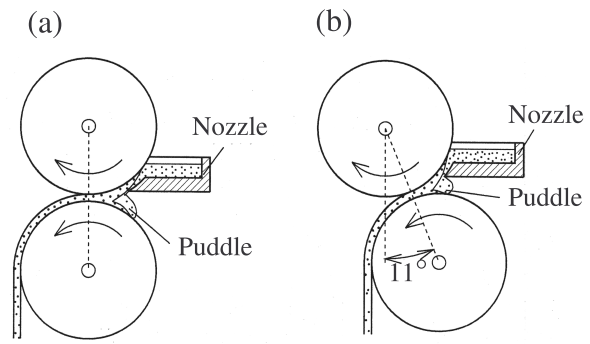


Fig. 3 Effect of an upper roll on a stability of a puddle. (a) a puddle is not stable, (b) a puddle is stable

3. EXPERIMENTAL RESULT

3.1 Roll speed

The strip could be cast at speeds from 10m/min to 40m/min. Sound strip could be cast at the speeds slower than 30m/min. In the conventional twin roll caster for aluminum alloy shown in Fig.1 (a), the roll speed (casting speed) was usually slower than 15m/min. Separating force of the DMDTRC was smaller than that of the conventional twin roll caster for aluminum alloys. However, the DMDTRC could cast the strips. In the DMDTRC, most of the thickness of the strip was solidified by the upper roll. Figure 4 shows effect of roll speed on the strip thickness. The strip became thinner as the roll speed becomes higher. This tendency was as same as other roll casters. When the roll speed was higher than 60m/min, the thickness of the solidification layer in the puddle was too thin in order to make flat the lower surface of the strip. When the roll speed was slower than 10 m/min, clogging occurred at the slope, or the melt was not dragged uniformly at lateral direction of the strip.

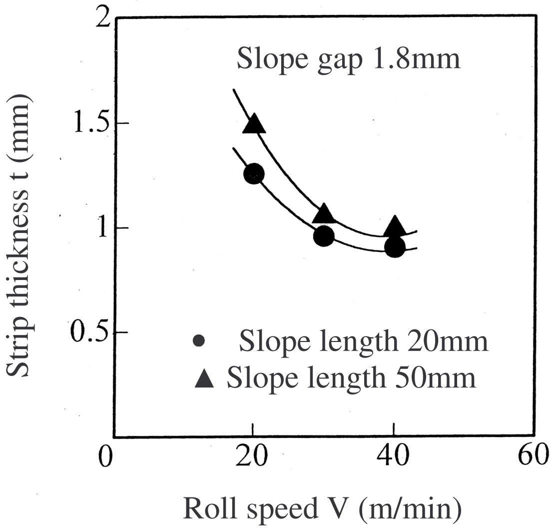


Fig. 4 Relationship among roll speed, slope length and strip thickness

3.2 Slope length

The slope is useful in order to stabilize the solidification, melt flow and melt temperature of the puddle. Figure 5 shows the effect of the slope length on the thickness of the strip. Figure 6 show schematic illustration around the slope of the nozzle and the puddle on the lower roll. The solidification layer on the upper roll becomes thicker as the slope length becomes longer. Solidification layer on the lower roll becomes thinner as the slope length becomes longer. The reason is that the melt dragged from the nozzle becomes less and the puddle becomes small as shown in Fig. 6, as the slope length becomes longer. As the result, the thickness of the strip becomes as shown in Fig. 5.

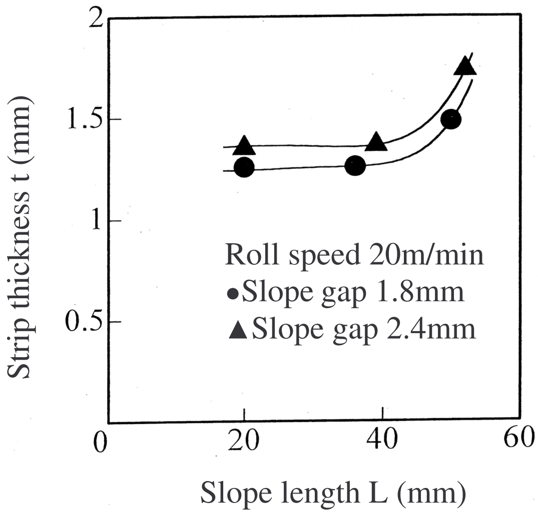


Fig. 5 Relationship among slope length, slope gap and strip thickness

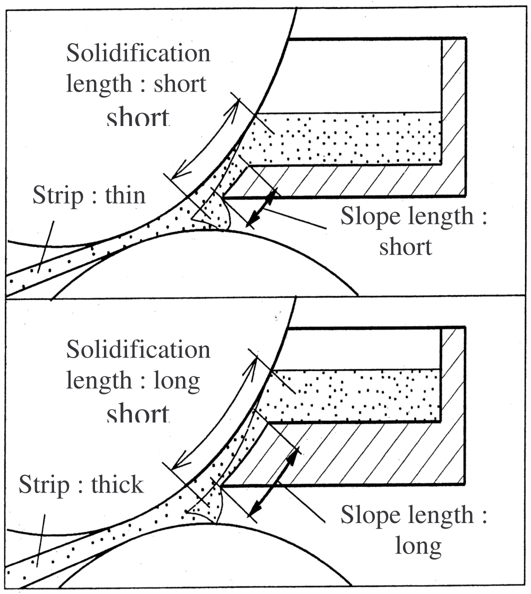


Fig. 6 Effect of the slope length on the solidification layer on the upper roll

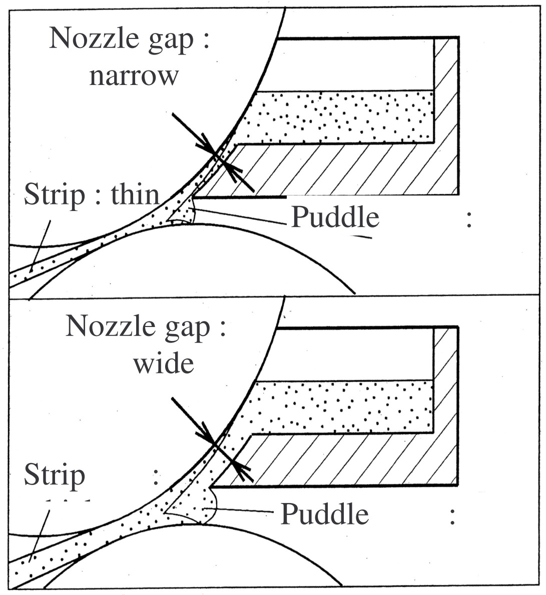
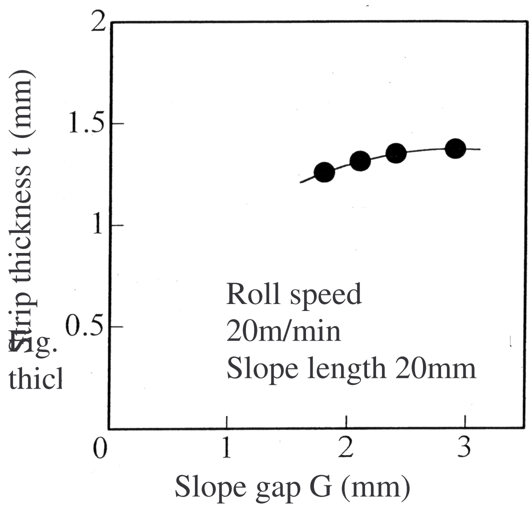


Fig. 7 Effect of the nozzle gap on the puddle on the lower roll

3.3 Slope gap

Figure 7 shows schematic illustration the effect of the roll gap on the puddle. The puddle becomes larger as the roll gap becomes wider. Figure 8 shows the relationship between the slope gap on the strip thickness. The strip becomes thicker as slope gap becomes wider. The solidification layer becomes thicker as the puddle becomes larger. The effect of the nozzle slope gap is not so large like the roll speed.



4. CONCLUSIONS

The downward melt drag twin roll caster was devised to cast strip or wire-inserted composite strip. Fundamental properties of the downward melt drag twin roll caster were investigated in the present study. The thickness of the strip could be controlled by the roll speed, the slope gap and slope length. The downward melt drag twin roll caster could cast the strip at the speeds higher than 10 m/min. The lubricant was not sprayed on the roll surface, as the strip did not stick to the roll. This is the effect of the use of the copper roll and the low separating force. Start of the casting is easy. This is one of the feature of the downward melt drag twin roll caster.