

**Development of ultra-high speed cutter  
for steel pipes and cast iron pipes**

***Main author***

*Takeo Kawamura*  
*Keiyo Gas Co., Ltd.*  
JAPAN

***Sub author***

*Hiroyuki wada*  
*Keiyo Gas Co., Ltd.*  
JAPAN

*Mikio Nakaoka, Hideo Hirabayashi*  
*Shinwa Sangyo Co., Ltd.*  
JAPAN

## 1. Abstract

The newly developed “Ultra High-Speed Cutter” consists of the hydraulic cutting unit, driving unit, fixed guide, and the fixed chain. The fixed guide and chain are specifically required for each diameter of pipe to cut. The other all units can be commonly used. The power source for the hydraulic method is supplied from the hydraulic power unit, also known as the self-driven excavator. This new technology is designed to precisely cut only the thickness of the pipe by moving the cutter along the rim in a circular motion. The tool can cut steel and cast iron pipes with an outer diameter of 165mm to 330mm. The cutting mechanism is as follows: The endmill of the hydraulic cutting unit rotates around the pipe along the fixed guide, while only cutting the wall thickness of the pipe. By using the drill-shaped endmill as cutting tool, it is able to perform without being trapped in stress folds of pipes that have been subjected to bending stress by earth pressure. It can also accomplish this task in a very short time.

**TABLE OF CONTENTS**

1. Abstract.....	2
2. Body of paper .....	4
2.1. Introduction .....	4
2.2. The structure of ultra-high speed cutter.....	4
2.2.1 . The endmill .....	5
2.2.2. The machining unit.....	5
2.2.3. The driving unit .....	5
2.2.4. The hydraulic power unit.....	5
2.2.5. The fixed guide .....	5
2.3. Performance of the ultra-high-speed cutter .....	5
2.3.1. Installation space of open cut .....	5
2.3.2. Cutting the several straight pipes .....	6
2.3.3. Cutting the bended steel pipes .....	7
2.3.4. Situation of the endmill .....	7
2.4. Summery and future task .....	8
3. List of Tables.....	9
4. List of Figures .....	9

## 2. Body of paper

### 2.1. Introduction

The maintenance of the gas pipeline system is very important for the gas suppliers. In Japan, old steel and cast iron pipes are frequently constructed into polyethylene. Recently in urban areas, time distribution for plumbing have been severely restricted. Work hours required to cut buried pipes have been reduced. For that reason, accurate results are required. In Japan, two kinds of pipe-cutting equipment have been used. One of the pipe-cutting equipment is the manual rotary pipe cutter. This tool is able to precisely cut only the wall thickness of the pipe by using a rotating blade. However, the cutting requires much time. The other equipment is the automatic saw cutter. This pipe cutter cannot cut pipes that have been subjected to bending stress due to earth pressure. As a result, the saw cutter will stop at the point in which the pipe has undergone bending stress. It is important to develop the cutting tools which can reduce the working time without failing for being trapped in stress folds of pipes

### 2.2. The structure of ultra-high speed cutter

The ultra-high-speed cutter is made up of the endmill (1), the machining unit (2), the driving unit (3), the fixed guide and the anchoring chain (4) and the hydraulic power system (5). The hydraulic power is supplied from general-purpose hydraulic power unit or the external hydraulic supply of the excavator. Also, the fixed guide and the anchoring chain are necessary for each diameter of the pipes. Standard features include for 150mm, 200mm, 300mm.

Operating mechanism is that the ultra-high-speed cutter with the endmill turns around the pipe in a circumferential direction along the fixed guide and the endmill cuts only the wall thickness of the pipe at the same time.

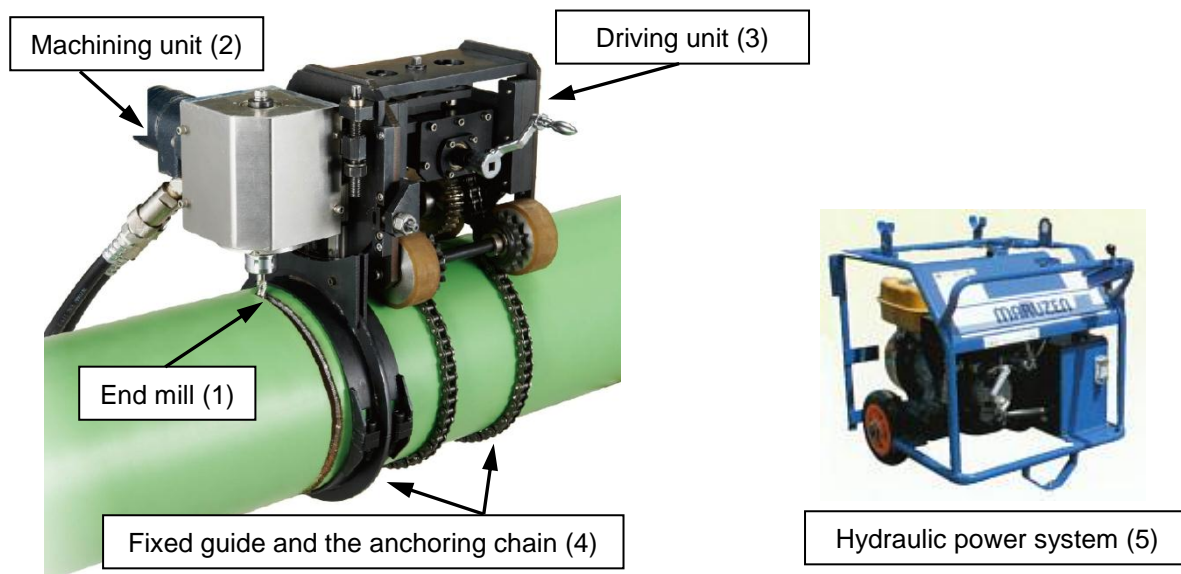


Figure-1 Structure of ultra-high speed cutter

### **2.2.1 . The endmill**

The roughing endmill 4 flutes type is selected for the following two reasons. The first is that the cutting time is reduced by cutting only wall thickness of pipe. The second is that the endmill can cut the pipes which are subjected to bending stress for earth pressure.

The endmill is generally used for milling groove. The developed endmill has two function of drilling and cutting. For this reason, it enable to cutting from the point of drilling point.

### **2.2.2. The machining unit**

The power source of this unit is used the hydraulic motor. The hydraulic motor enable to generate bigger rotating torque than electric motor in the machining unit. And also this hydraulic motor can be used in drilling hole without explosion-proof and enclosed.

### **2.2.3. The driving unit**

The driving unit can be moved by rotating the small handle manually. It can advance 3 degree around the pipe during one rotation of the small handle. Even when the endmill is cutting the pipes which are subjected to bending stress, the driving unit can be moved by stress less manually. In addition, washing is not required.

### **2.2.4. The hydraulic power unit**

The power source for the hydraulic unit is supplied from general-purpose hydraulic power unit or the external hydraulic supply of the excavator. When the hydraulic power surpass the capacity of the hydraulic motor, it requires the pressure-compensated flow control valve. (The capacity of the hydraulic motor is under 30 liters per minute and under 14.0 MPa.)

### **2.2.5. The fixed guide**

The fixed guide enable not to slip by reaction force of cutting the pipe. Standard features of the fixed guide and the anchoring chain include for the 150mm, 200mm, 300mm. The fixed guide can be positioned on the steel pipes and cast iron pipes without defacing. It can be positioned on a polyethylene lined steel pipe as well.

## **2.3. Performance of the ultra-high-speed cutter**

### **2.3.1. Installation space of open cut**

It requires that the space for open cut is over 300mm from all-around surface of the pipes. Actually the height of the ultra-high-speed cutter is under 250mm. Even if the another embedded pipes are nearby, this cutter enable to cut the pipes. Figure 2 shows the installation space for the ultra-high-speed cutter of open cut.

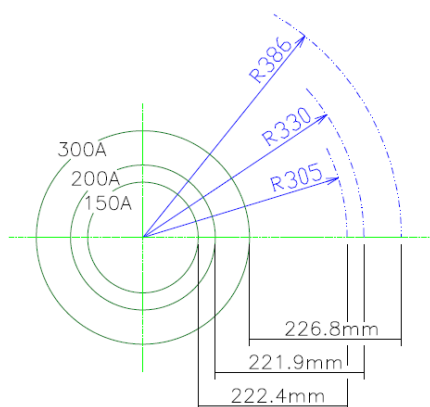


Figure-2 Installation space

### 2.3.2. Cutting the several straight pipes

Table-1 shows the cutting time for the several straight pipes. The hydraulic power was supplied from general-purpose hydraulic power unit or the external hydraulic supply of the excavator. Table-2 shows the condition of hydraulic power.

Table-1 Cutting time for several straight pipes

Pipes		Cutting time	
Size	Type	General-purpose hydraulic power unit	The external hydraulic supply of the excavator
150A	Cast iron pipes	4 min	-
	PE lined steel pipes	4 min	4.5 min
200A	Steel pipes	5 min	-
	Cast iron pipes	5 min	7 min
	PE lined steel pipes	5 min	-
300A	PE lined steel pipes	-	10 min

Table-2 Condition of hydraulic power

	The hydraulic power	
	General-purpose hydraulic power unit	The external hydraulic supply of the excavator
Flow rate	20 L / min	-
Pressure	11.7 MPa	-
Rotation number of endmill	-	780p.m.

### 2.3.3. Cutting the bended steel pipes

Table-3 shows the cutting time of the bended 200A steel pipes. The hydraulic power was supplied from general-purpose hydraulic power unit. The condition of hydraulic power is shown in Table-2. Table-4 shows the bended condition of steel pipes.

Table-3 Cutting time of bended steel pipes

Pipes		Bended condition	Cutting time	Appearance
Size	Type			
200A	Steel pipes	The proportional limit	5 min	Smooth cutting surface of fixed side
		The buckling limit	5 min	Smooth cutting surface of fixed side

Table-4 Bended condition of 200A steel pipes

Bended condition	Calculated stress
The proportional limit	174 MPa
The buckling limit	290 MPa



Figure-3 Cutting the bended steel pipe

### 2.3.4. Situation of the endmill

The temperature of the endmill is up to about 140 degree Celsius during cutting the pipes. If it is cooled by water, the temperature of the endmill falls to about 40 degree Celsius. In that case, the cutting length with one endmill is over 60000 mm.

### **3. Summery and future task**

In this development, we tried to evaluate the feeding mechanism of the driving unit and cutting performance of several endmills. As a results, it was found that the driving gear ratio is very important for manual operation and the drill-shaped endmill plays an important role to prolong the length of the cutting. Therefore, this "Ultra high speed cutter" can complete to cut the pipe in quarter the times compare to the traditional blade saw cutter. And also this "Ultra-high speed cutter" made very short time cutting without sticking the endmill bit between the pipes which are subjected to bending stress possible.

In the near future, it can be used for bevel cutting for welding and cutting in a longitudinal direction for the branch construction from a polyethylene pipe into the cast iron pipe or the steel pipe.



#### **4. List of Tables**

Table-1 Cutting time for several straight pipes

Table-2 Condition of hydraulic power

Table-3 Cutting time and appearance for bending steel pipes

Table-4 Bended condition of 200A steel pipes

#### **5. List of Figures**

Figure-1 Structure of ultra-high speed cutter

Figure-2 Installation space

Figure-3 Cutting the bending steel pipe