

# New Developments in Cut Wire Shot for Shot Peening

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## 1 Introduction

Today's production of dynamically stressed components in many industrial branches requires Shot Peening applications with a high level of optimized processes and materials. The media used in that processes is becoming more important to achieve best results at the parts surface and to run the application in the most economical way. This recognition was the reason for a two years research at R+K Draht GmbH to develop a Conditioned Cut Wire Shot ("Special Quality") that corresponds to the a.m. needs much better than conventional well known Conditioned Cut Wire is doing today. The extensive research period was finished in 1999 and was continued by a period of large scale tests in industries with various applications. Special Quality showed its drastic increased lifetime and provides industries a shot peening media that allows to run also applications where hardnesses with 700 HV (60 HRC) and above are needed in an economical way for the first time. The following presentation shows the results that could be achieved in industrial applications during the last years.

### 1.1 Short History of the Development of Dynamically Stressed Components

Dynamically stressed components are mainly:

- springs,
- gears
- aircraft components

The technical development of these applications is characterized by highest dynamic. The increasing request to the performance of these components caused permanent innovation:

- material alterations
- new constructions
- new raw materials
- increased strengths
- new technologies in production

### 1.2 Development of Shot Peening Media

In the past major use of shot peening media was cleaning of surfaces. The cognitions by WÖHLER that special tensions at the surface of parts increase the life time substantially, were applied in large-scale production with the introduction of the shot peening process to the production of dynamically stressed components. This process without shot peening today is in-

conceivable. Initial shot peening media mainly were made of steel cast. Using of Cut Wire Shot became a very important alternative. Advantages of Cut Wire Shot are:

- increased regularity of mechanical characteristic
- closer tolerances of hardness
- more uniform screen structure
- increased lifetime

The analysis of shot peening media situation shows that the development of shot peened parts is much faster than the development of the needed shot peening media. To open opportunities for Shot Peening applications which meet future demands it is necessary to find ways for a Conditioned Cut Wire Shot that will provide better technical and economical characteristics.

## **2 Requirements on Dynamically Stressed Components**

The requirements in general are:

- very long lifetime
- smaller size of components
- cost reduction

Ways to get there:

- on one hand changes in the raw materials and the production process of these parts
- and on other hand by harden the surfaces with shot peening

## **3 Requirements on Shot Peening Media**

By analysing the mentioned situation we derive the recognition that there is a delay of development in Conditioned Cut Wire Shot in two directions:

First is lifetime of cut wire shot, including the influence to the costs and second point is the ratio hardness / lifetime and costs of Cut Wire Shot.

## **4 Examinations at R+K Draht GmbH**

### **4.1 Examination of Lifetime**

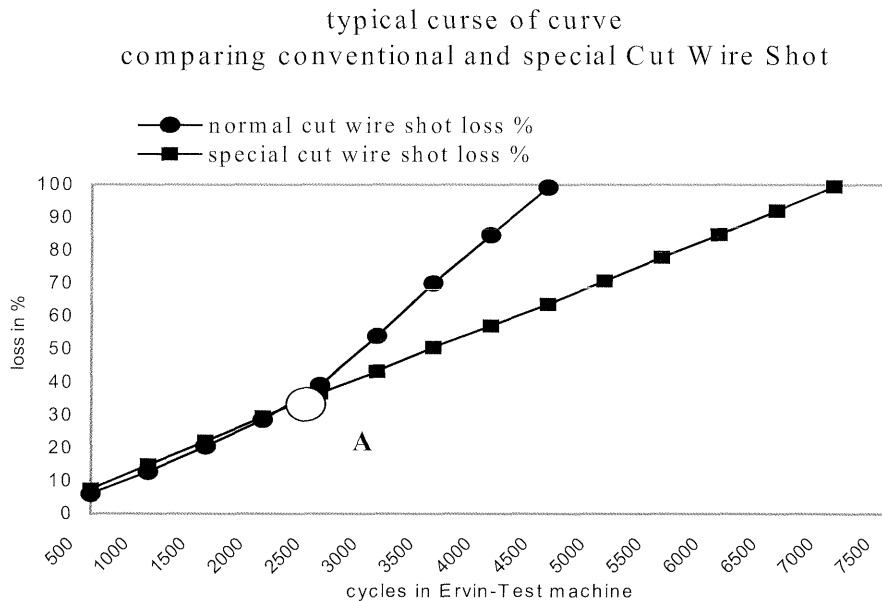
The procedure of the examination of lifetime and the limited values are prescribed at VDFI 8001. The above-mentioned procedure – the Ervin Test – is a prestigious method to describe the duration of the shot peening media in practice. The increase of the Ervin-values means also a decrease of consumption of shot peening media in minimal the same equivalent percentage.

The increase of lifetime of media tested with the Ervin-Test machine to 140 % means in practice a decrease of consumption of 40 to 50 %.

With an additional operation (heat treatment) it was reached that the lifetime was increased to 140 to 160 % as compared with conventional Cut Wire Shot. The expansion of the loss of conventional cut wire shot is nearly identical to special cut wire shot up to 2.200 cycles (point A) in the Ervin-Test machine. From this point the breaking characteristic of conventional shot changes drastic. The loss increases, the Ervin-Test curve breaks away. If using cut wire shot made of drawn steel wire there is a uniaxial tension state. The particles breaks in longitudinal axis and rounds again. This is a critical phase, because there are sharp-edged particles that could cause violations at the parts surface.

In difference to that the new Special Quality with heat treatment has a normalized inner structure so that the breaking characteristic is not influenced by unfavorable tensions. The use of this new special cut wire shot guarantees a very uniform structure that also wears out like that. The rate of breaks is minimal, the danger of surface violations nearly excluded. Only occasional particles break, the most quota wears out to its spherical form more and more.

The production of **special cut wire shot** is not cost-neutral. But cost reduction by increase of



**Fig. 1:** Comparison of lifetime of conventional and special Cut Wire Shot (dia.: 0,6 mm, shape: elliptic, hardness: 640 HV1)

the lifetime is proved. Further advantages like decrease of decay, reduction of efforts for handling and other are possible. In Table 1 all achieved results are shown. This list is to be continued.

**Table 1:** Achieved increase of lifetime with conditioned cut wire “special quality”

Dia-meter/ mm	Hardness Vickers		Lifetime/ number of cycles in Ervin test machine						Increased lifetime with condi- tioned cut wire ”special quality”		
	nomi- nal	Toleran- ces	conditioned cut wire “conventional”			conditioned cut wire “special quality”			Shape**		
			Shape**	Shape**	Shape**	Shape**	Shape**	Shape**	Shape**	Shape**	Shape**
HV 1*	HV 1*	G 1	G 2	G 3	G 1	G 2	G 3	G 1	G 2	G 3	
0,30	640	610–670	4600	4500	4400	9700	9600	9500	210,87%	213,33%	215,91%
	670	640–700	4500	4400	4300	9600	9500	9400	213,33%	215,91%	218,60%
	700	670–730	4600	4500	4400	9500	9400	9300	206,52%	208,89%	211,36%
0,40	640	610–670	4400	4300	4200	9400	9300	9200	213,64%	216,28%	219,05%
	670	640–700	4300	4200	4100	9300	9200	9100	216,28%	219,05%	221,95%
	700	670–730	4400	4300	4200	9200	9100	9000	209,09%	211,63%	214,29%
0,50	640	610–670	4200	4100	4000	8800	8700	8600	209,52%	212,20%	215,00%
	670	640–700	4100	4000	3900	8700	8600	8500	214,00%	215,00%	217,95%
	700	670–730	4200	4100	4000	8600	8500	8400	207,00%	207,32%	210,00%
0,60	640	610–670	4000	3900	3800	6500	6400	6300	162,50%	164,10%	165,79%
	670	640–700	3900	3800	3700	6400	6300	6200	164,10%	165,79%	167,57%
	700	670–730	4000	3900	3800	6300	6200	6100	157,50%	158,97%	160,53%
0,70	640	610–670	3700	3600	3500	6000	5900	5800	162,16%	163,89%	165,71%
	670	640–700	3600	3500	3400	5900	5800	5700	163,89%	165,71%	167,65%
	700	670–730	3700	3600	3500	5800	5700	5600	156,76%	158,33%	160,00%
0,80	640	610–670	3500	3400	3300	5500	5400	5200	157,14%	158,82%	157,58%
	670	640–700	3400	3300	3200	5400	5300	5100	158,82%	160,61%	159,38%
	700	670–730	3500	3400	3300	5300	5200	5000	151,43%	152,94%	151,52%
0,90	640	610–670	3300	3200	3100	4800	4700	4500	145,45%	146,88%	145,16%
	670	640–700	3200	3100	3000	4700	4600	4400	146,88%	148,39%	146,67%
	700	670–730	3300	3200	3100	4600	4500	4300	139,39%	140,63%	138,71%

\* for evaluation 0,30 mm it is to use HV 0,5

\*\* shape: G1 = broken edges, G2 = elliptical, G3 = ball

## 4.2 Examination of Hardness

If industries are looking for Cut Wire Shot with hardnesses above 700 HV (60 HRC), a contrast between the high hardness and increased wear is to be mentioned. Very often the use of Condi-

tioned Cut Wire with that high hardnesses causes high costs by rapid wear of the material. Solutions could be:

- a) to increase the tensile strength of the drawn wire
- b) use of different raw materials
- c) to optimize the production procedure

By considering these three opportunities it was the target to find the best ratio of highest hardness, highest lifetime and economical production. In Table 2 examples are shown:

**Table 2:** Examples of cut wire shot with higher hardnesses and increased lifetime

Diameter	Shape	Hardness	Lifetime	
mm		HV 1	Cycles in Ervin Test	
0,35		ellyptic	HV 750 ( $\pm$ 30)	3500
0,50		ellyptic	HV 750 ( $\pm$ 30)	3740
0,60		ellyptic	HV 750 ( $\pm$ 30)	4000

## 5 Benefits and Profits

The application of **special cut wire shot** saves media as compared with conventional cut wire shot about 30-60% and offers cost-reduction of about 10-20%.

The exact amounts are to be calculated by the actual basis at the user. The actual basis is described as follows:

- a consumption kg/shot peening hour
- b composition of operating mixture
- c technical specification of the applicated cut wire shot

The saving refers to the consumption kg/shot peening hour.

The composition of operating mixture is keeping constant, like actual basis