OPTIMAL 'ELIGIBILITY FOR FUNDING' OF WELDING WIRE

Process reliability in processing thanks to clean wire with ideal feeding properties

The following discussion focuses on the surface properties, or the "eligibility," of welding wires. The metallurgical properties of the wires are not relevant here.

Based on numerous tests and analyses of welding wires and their quality when used in welding, Richard Fichtner, a development engineer at GEO Reinigungstechnik GmbH and the author of this article, describes the term "weldability" as "a story rife with misunderstandings." For what is actually meant by "conveyability" (or "conveyance resistance"), and how can "conveyability" be defined?

Welders — and thus the users — say that the wire is "bad" or "doesn't feed properly." To them, "the wire just doesn't run right," it "rubs too hard and needs better lubrication," or it "rattles." This is how the term "feedability" describes the product's characteristics in practice. But is "feedability" measurable?

A common method is to measure the friction (feed force) of the wire in the feed section (feed hose and contact tip). To this end, sensors are placed at the inlet of the feed section to measure the feed force required to transport the wire through the feed section. However, according to Richard Fichtner, this method provides only a rather vague picture of the wire's "feedability" in the welding process. In his opinion, the causes of the "problems" described above lie in changing conditions within the feed path, which are supposedly reflected in the "behavior" of the wire at the contact tip and the resulting effects on the "feed geometry." The following three schematic diagrams (Figures 1–3) illustrate this view.

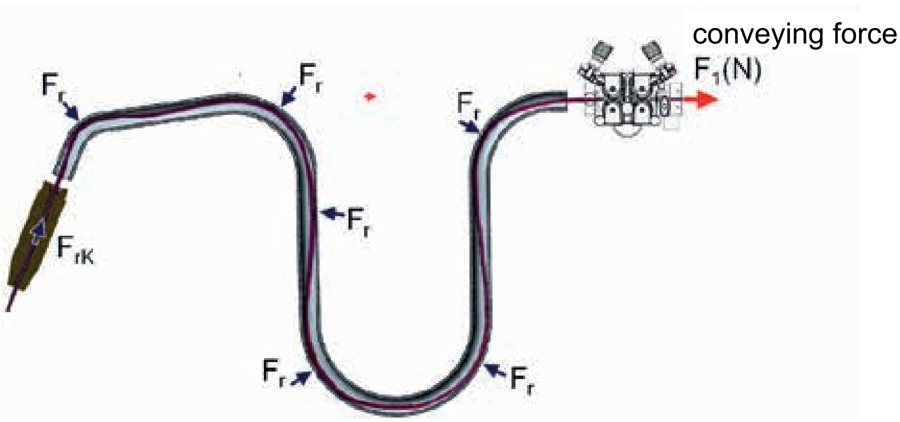


figure 1:
The wire has free space within the conveyor hose and the friction force at the contact tip (FrK) causes the wire to compress within the hose to an extent proportional to the magnitude of this force (FrK), resulting in pressure marks on the wire against the hose wall with friction forces Fr.
The conveying force F1 is composed of the sum of these forces: F1 = FrK + 6Fr.

As long as the friction force at the contact tip (FrK) does not change (increase), the conveying force F1 also remains nearly constant.

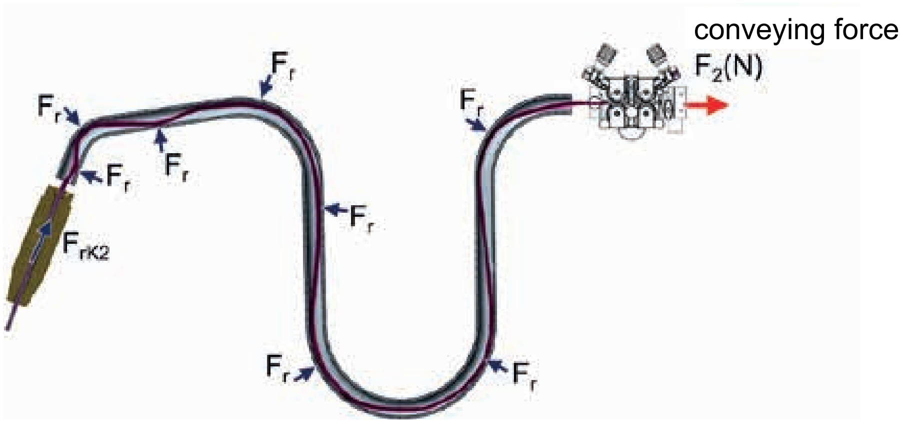


figure 2:
If the frictional force at the contact tip increases briefly (< 1 sec.), this leads to the formation of additional contact points for the wire in the feed hose near the contact tip, also for a brief moment.
This is noticeable during the welding process, i.e., the welder can feel it as well. However, due to the long distance
from the contact tip to the point where the feed force is measured, the transmission is dampened and is not adequately captured during the measurement of the feed force.

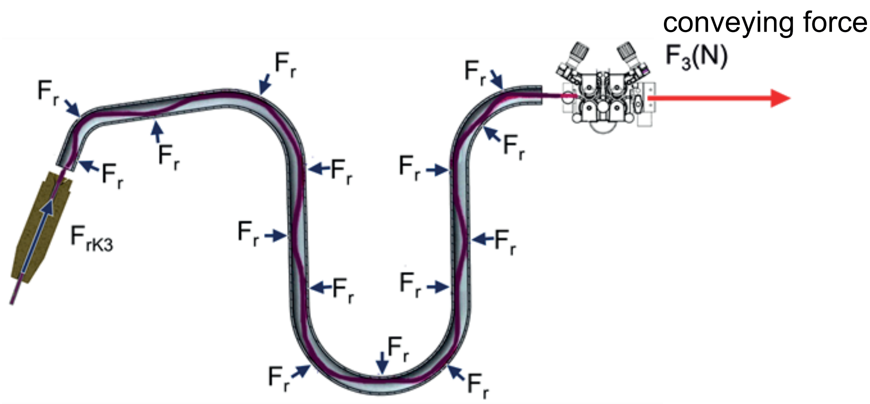


figure 3:
If the frictional force at the contact tip increases for an extended period (> 1 sec), this leads to additional contact points along the wire throughout the conveyor hose and a significant increase in the conveying force F3 = FrK3 + 15Fr.

Figures 1 through 3 primarily illustrate the impact of the wire's behavior within the contact tip on the entire "feed hose" system. In practice, however, the wire is not simply guided through a narrow tube—i.e., the bore of the contact tip—but high currents are simultaneously transmitted during welding. According to Richard Fichtner, this has a decisive influence on the welding process. The prerequisites for good current conduction are a sufficiently large contact area and low contact resistance.
A reduction in the contact area or an increase in contact resistance during current conduction leads to the formation of arcs.

When it comes to the passage of the welding wire through the contact tip — where relatively high currents are transmitted through a relatively small contact area — even marginal changes in the contact area can lead to the formation of micro-arcs and the melting of material inside the contact tip.
This is usually caused by surface defects on the wire or a change in contact resistance due to excess lubricant or accumulated contaminants. If the melted material does not solidify immediately upon exiting the contact tip, the welder perceives this disruption to the wire's movement as vibration.

Conventional measurements of conveying force typically detect the disturbances described above with a time delay due to the long transmission paths. These disturbances are consequently interpreted as increased friction or fluctuations in the wire throughout the entire hose assembly. To reduce friction, more lubricant is then applied to the wire in practice. This, in turn, leads to a further increase in contact resistance and, as a result, often to a further deterioration of the results.

The GEO WWTE & WWTE-TV inspection systems take a comprehensive approach. They focus on the wire surfaces and their impact on the welding process. The WWTE & WWTE-TV systems thus enable an objective assessment of how the properties of the welding wires, as determined by their surfaces, affect the welding process. In addition, an optical inspection of both the wire surface and the contact tip can be performed using the associated microscope station.

The WWTE system was developed to inspect welding wires directly during the welding process. Customers use it for quality assurance and for comparative testing in cases of customer complaints, among other purposes. During the welding process, the following parameters are recorded simultaneously and plotted on a timeline:

— Conveying resistance F (in newtons);

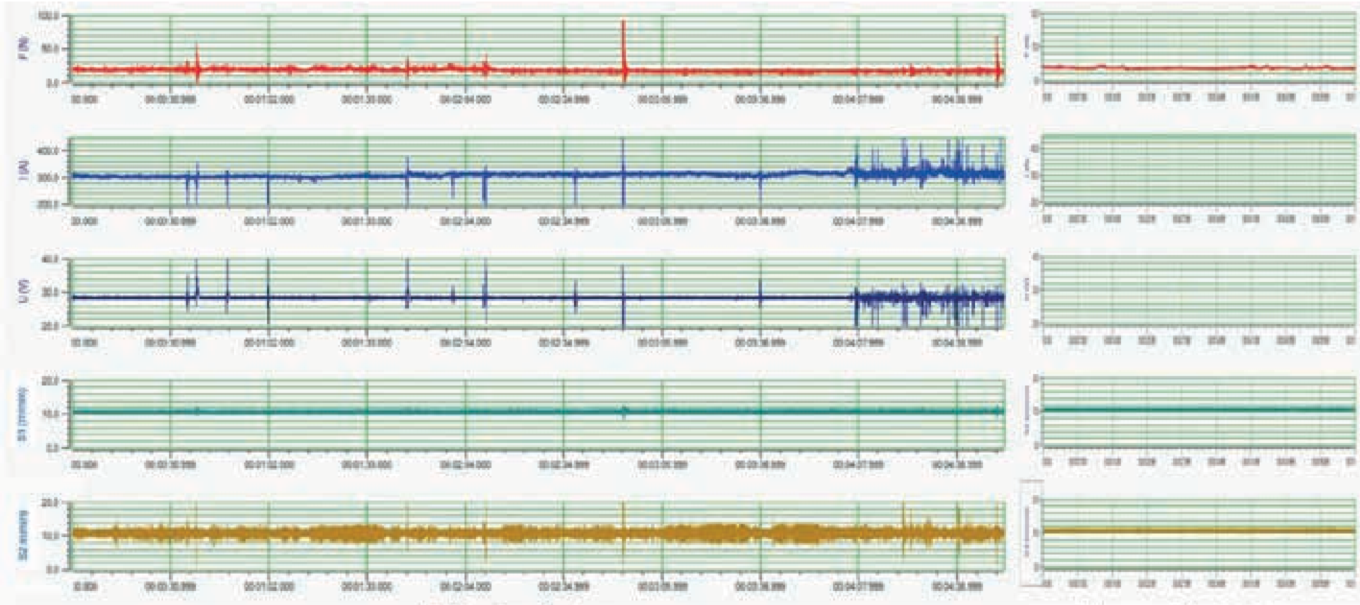
— Welding current I (in amperes);

— Welding voltage U (in volts);

— Wire speed S1 (in m/min) immediately after the feed rollers. The magnitude of the standard deviation σS2 of this wire speed is an indication of the slip in the feed rollers;

— Wire speed S2 (in m/min) immediately in front of the welding gun.
The magnitude of the standard deviation σS3 of this wire speed is an indication of contact or sliding problems with the wire in the contact tip.

The parameters F, S1, and S2 are also recorded without welding. The values can then be compared and statistically analyzed.
The following figure (Figure 4) shows, by way of example, the measurement results for the "Aristorod" wire.



Measured parameters/ Измеренные параметры	Welding time 5 minutes: F (N)	I (A)	U (V)	S2 (m/min)	S3 (m/min)	without welding 1 minute: F (N)	S2 (m/min)	S3 (m/min)
Mean/ средняя величина	18,3	309	28,5	10,8	10,8	19	10,7	10,8
Range /максимальный разброс	96	471	81	4,7	36	12	1,56	2,6
Standard deviation/ стандартное отклонение	2,7	14	1,6	0,22	0,94	1,5	0,18	0,33

figure 4:
The curve for the feed force (F) remains constant both without welding (Fig. right) and during welding (Fig. left). No differences are visible in the curves for the wire speeds S1 (here S2) and S2 (here S3) when welding is not taking place. During welding, clear differences can be seen. These fluctuations in speed S2 (here S3) during welding are perceived by the welder as vibrations.

The **WWTE-TV** testing device is designed for quality assurance both in production and during incoming inspection at welding wire users' facilities. Unlike the WWTE system, testing with the WWTE-TV is performed without generating an arc. Certified welders and a specially equipped workstation with ventilation, light shielding, etc. are not required.
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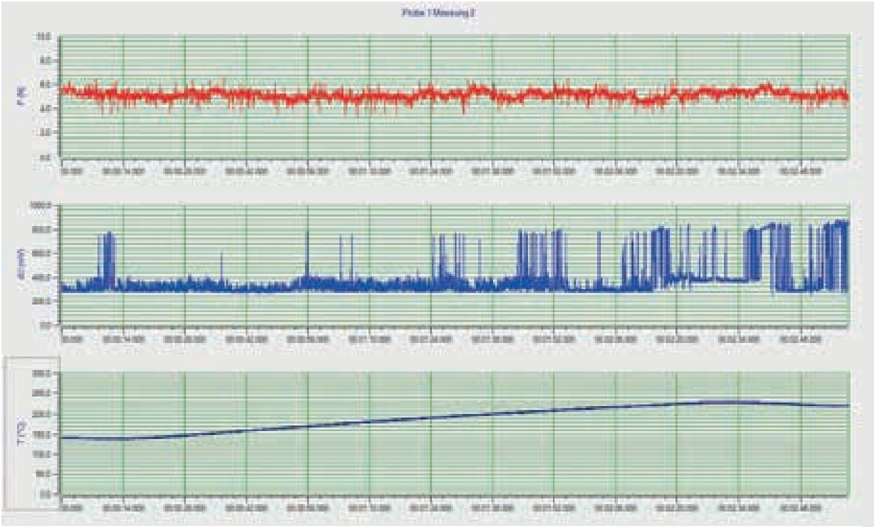
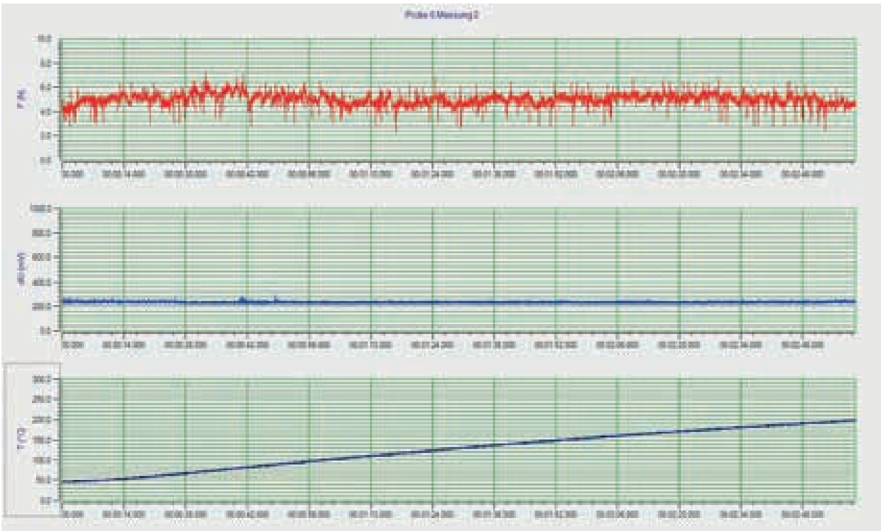
For testing with the WWTE-TV, the welding wire is pulled or pushed through a feed hose (the type is freely selectable) and through the contact tip at a speed of 5 to 15 m. During this process, at a constant current of 20 A, the feed resistance and the voltage drop in the
contact tip are continuously measured and simultaneously recorded. To simulate the conditions present during an arc, the contact tip can additionally be heated up to 300°C.

Figures 5 and 6 below show two examples of measurements taken with the WWTE-TV
of two wires from the same production run.



Messparameter / Measured Parameters	F (N)	dU (mV)	T°C
Mittelwert /Average	5,2	362	190
maximale Variation / Maximum Rash	3,4	658	97
Standardabweichung / Standard deviation	0,25	144	31

figure 5:
wire from a batch subject to a complaint



Messparameter / Measured Parameters	F (N)	dU (mV)	T°C
Mittelwert /Average	5,0	232	125
maximale Variation / Maximum Rash	4,9	81	156
Standardabweichung / Standard deviation	0,35	6	46

figure 6:
Wire produced using an improved drawing process and reduced lubricant application

The upper curves for conveying force (F) show that the results for conveying force are virtually identical. However, the results for voltage drop indicate that the wire from the batch subject to a complaint exhibits significant contact issues, particularly at higher temperatures.
The welder would perceive the measured fluctuations in the voltage drop curve as vibrations.

GEO Reinigungstechnik conducts tests on behalf of customers using the WWTE test system or the WWTE-TV testing device upon request. The measurements documented in our technical article in the journal Schweißen & Schneiden 69 (2017), Issue 9 were obtained using the WWTE test system.

You can find a video about WWTE-TV on our YouTube channel:
https://www.youtube.com/user/GeoReinigungstechnik/videos

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