NOVATEUR PUBLICATIONS
International Journal of Research Publications in Engineering and Technology [IJRPET]
ISSN: 2454-7875
VOLUME 3, ISSUE 4, Apr.-2017

EXPERIMENTAL ANALYSIS & DETERMINATION OF VARIOUS PLAIN CARBON STEELS BY USING SPARK TESTING

KEVAL H RAWANI
Department of Mechanical Engineering Konkan Gyanpeeth College of Engineering, Karjat. Raigad, Maharashtra, India.
kevalrawani09@gmail.com

SOURABH V PAINJANE
Department of Mechanical Engineering Konkan Gyanpeeth College of Engineering, Karjat. Raigad, Maharashtra, India.
srbhpainjane036@gmail.com

AKSHAY P SALUNKHE
Department of Mechanical Engineering Konkan Gyanpeeth College of Engineering, Karjat. Raigad, Maharashtra, India.
akshayrajsalunkhe@gmail.com

SANKET S PATIL
Department of Mechanical Engineering Konkan Gyanpeeth College of Engineering, Karjat. Raigad, Maharashtra, India.
sanket.patil28@gmail.com

PROF. S.S.DHARMARAO
Assistant Professor, Department of Mechanical Engineering Konkan Gyanpeeth College of Engineering, Karjat. Raigad, Maharashtra, India. sumitdharmarao@gmail.com

PROF. P.M.DESHPANDE
Assistant Professor, Department of Mechanical Engineering Konkan Gyanpeeth College of Engineering, Karjat. Raigad, Maharashtra, India. pravin0171@rediffmail.com

ABSTRACT:

Knowledge of material properties, production methods and manufacturing processes are each important subject in the material science discipline. Material testing methods are standardized by several organizations, such as ASTM, ISO, ASM and DIN etc. Materials are tested and their mechanical properties are tabulated in handbooks. This project will explain a study conducted on how a certain number of carbon steels might be identified through the observation of the sparks projected when a specimen is held against a grinding wheel. There are many factors that can change the spark patterns that are projected, but the main goal of this project is to attempt to standardize a method of spark testing and how it is performed. The study was conducted on six different grades of carbon steels that are commonly used in manufacturing processes. A reference manual was created from the experimental data cataloguing the spark pictures. This manual can be used by students and potentially by machine shops to identify samples of the included materials. This can lead to significant savings for machine shops by using a relatively easy, user friendly method, to identify unknown stock sitting around in the shop.

KEYWORDS— Material, spark testing, material science, material identification.

1. INTRODUCTION:

Part of the metalworker's skill lies in the ability to identify various metal products brought to the shop. The metalworker must be able to identify the metal so the proper work methods can be applied. They must be examined in order to determine the metal to be used & its heat treatment. If no drawing is available, knowledge of what the parts are going to do will serve as a guide to the type of metal to use. Due to this reason metal testing can easily help to identify the metal composition.

2. SPARK TEST:

Spark testing is a method of determining general classification of ferrous materials. Its normally entails taking a piece of metal, usually scrap, & applying it to a grinding wheel in order to observe the sparks emitted. The sparks can be compared to a chart or to sparks from a known test sample to determine the classification. Spark testing also can be used to sort ferrous materials, establishing the difference from one another by noting whether the spark is the same or different.

The spark test is made by holding a sample of the material against an abrasive wheel. By visually inspecting the spark stream, an experienced metalworker can identify the metals with considerable accuracy. This test is fast, economical, convenient, and easily accomplished, and there is no requirement for special equipment. We can use

this test for identifying metal salvaged from scrap. Identification of scrap is particularly important when selecting material for cast iron or cast steel heat treatment. [1]

A). HISTORY:

Spark testing began around 1909 and continued on into the 1970's. However, these studies required a special or dedicated grinder and an experienced metal worker. An unknown piece of steel would be placed against a grinding wheel and the experienced worker would observe the sparks, the worker would then compare the spark patterns to the spark patterns of known pieces of steel. This identification process took years of experience to perfect a technique that would give consistent results.

In 1909, Max Bermann, an engineer in Budapest, was the first to discover that spark testing can be used reliably to classify ferrous material. He originally claimed to be able to distinguish different types of ferrous materials based on percent carbon and principal alloying elements. Moreover, he claimed to achieve an accuracy of 0.01% carbon content.

B). ADVANTAGES:

1. One of the biggest advantage of using this metal composition test is that it can be applied to metal, is best conducted by all stages.
2. It is quick, easy, and inexpensive.
3. It can also be applied to scrap materials.
4. Spark test can be carried by unskilled workers.

C). LIMITATION:

1. Spark metal composition testing is not of much use on pure nonferrous metals such as coppers, aluminums etc. since they do not exhibit spark streams of any significance. However, this is one way to identify the ferrous metals like plain carbon steel.
2. The angle in which the material is been identified should be proper & accurate because as angle changes length of spark changes so it will make difficulty to identify the type of spark.

3. PROBLEM DEFINITION:

In any industry, carbon steel with a specific composition is required to manufacture a product in an efficient way.

If carbon steel does not have a required composition there properties may get changed and due to that we can't make a product effectively. If we use mild steel or low carbon steel with 0.3% carbon content but due to procurements faults or manufacturing faults the carbon content is 0.5% then instead of mild steel or low carbon steel we use a medium carbon steel.

Due to this defect the various properties of low carbon steel gets slightly changed, like medium carbon steel is stronger and harder than low carbon steel also its ductility get reduced due increase in strength. The medium carbon steel is difficult to cold work, also its machinability and weldability reduces. And due to this change in its properties its application also changes.

With above mention problem, there are also some other problems comes in industry. Like while buying different steel material in larger lots there will be a chance of mislabeling the material from dealer so it is important to get to identify steel because carbon steel are more likely look same so we can't identify them visually. Also the scrap material in the workshop or industry is needed to identify before use.

So by considering all these factors it is necessary to identify the type of steel or in another word it is important for steel especially plain carbon steel to determine approximate percentage of carbon content present in the steel (carbon steel).

There are various method used for determining the percentage of carbon content in the steel/carbon steel. But the equipment/machines used for such test are costlier and required some standard surrounding condition; also they required a skilled operator, so it is not feasible to use such a hi-tech technology in a small scale or medium scale industries. These can be used in large scale industries to get accurate % carbon content.

4. METHODOLOGY:

Step1 - Random selection of carbon steel samples-

We mainly selected various types of carbon steel samples from market for a test.

Step2– Preparation and testing of those samples in testing laboratories-

After the carbon steel samples are selected they are took to the spectrometry lab where there exact proportion are been known. According the required sample of material is been selected. If the sample fails due to same results, samples are again been selected & have been retested till the required the different sample of carbon steel is obtain. The results of sample test are:

Table 1 – Material specification with Carbon Content

Sr No.	Material	Equivalent to Material	Actual Carbon content (%)
1	C8	C8	0.082
2	C18	C18	0.188
3	C40	C40	0.393
4	C45	C45	0.450
5	EN-9	C55	0.531
6	C95	C95	1.037

Step3 - Detail study of spark testing (Different factors to be considered in spark testing)-

After the composition test, the detailed study of spark test is been carried which gives us the basic reasons for selecting spark test in place of other testing methods, factors that affecting the spark pattern.

The grinder used in this project is a Baldor model 8123WD eight inch bench grinder rated at ¾ hp and 3,600 RPM. The lengths of the sparks emitted were rapidly shortened due to the fouling and gave inconsistent results. It was, therefore, decided to present the results of the 24 grit aluminium oxide wheel for 10sec only.

The force of gravity was utilised to create a constant force between the steel specimen and the grinding wheel. By attaching a custom built arm to the eight inch bench grinder, the force on the grinding wheel was kept at a constant force of 24 Newtons. This meant that any variation in the spark stream would be due to a variation in the carbon steel instead of the force applied to the specimens. The variations that were present in the spark stream were used to help determine the identification of the carbon steel.

Grinding wheel used:

EN12413 ANSI B7.1

Manufacturer: Carbonrundum Universal Ltd.

Abrasive Grain: Ceramic

Grain size: 24grit Fine

Wheel Dimensions:

1) Inner Diameter- 3.75mm
2) Outer Diameter- 160mm
3) Width- 25.4 mm i.e. 1 inch.

Step4 - Deciding dominant factors-

As while experimenting on the grinding wheel we found that the spark stream get changes due to angle of contact and also the position of carbon steel bar because there may be a chance that spark can get diverted in the casing due to improper position of carbon steel bar on grinding wheel. So the angle of material during operation is keep optimum which is 70-80^{o}and the point of contact of bar is in an angle between 15-45^{o} from the casing of the grinder.

Step5 - Design of fixture for testing with conventional bench grinder-

Fixture is been designed for carrying test by considering various factors. Beside the type of locator as well as the clamping devices are been decided for fixture.As well as various design considerations are been consider for the fixture. Alongside with it the fixture is been held by the pin to the fixed bar, the design consideration for designing pin is also been considered.

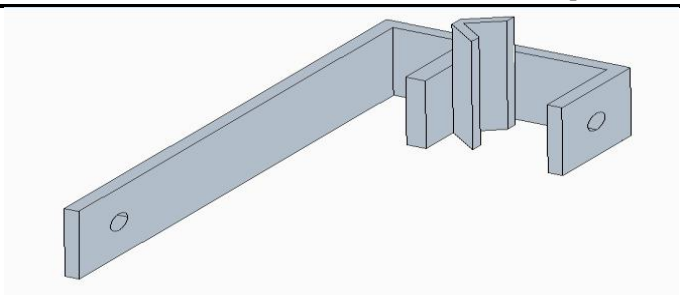

Fig.1 custom build swing arm fixture modeling on Creo2.0

Step6 - Conducting test and collecting data-

The test is been conducted by holding the material of known carbon content against the grinding wheel at 75^{o} angle that gives off spark emissions. When we hold a piece of iron or steel in contact with a high speed abrasive wheel, small particles of metal are torn loose so rapidly that they becomes red hot. The amount of spark or lacks of spark given off help the metal Click a picture and video of it and note down the results. For all other number of samples same procedure would be carried and note down its readings. We also going to use software for accurate reading so it will help in future and getting actual length and angle of spark test.

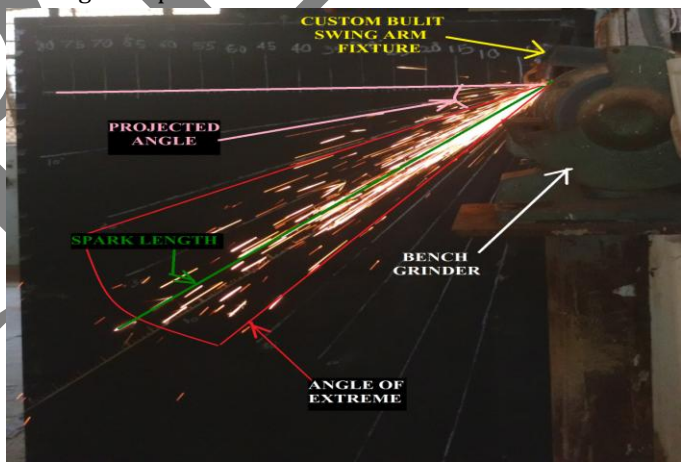

Fig.2 Steel sample held against grinding wheel

Step7- Interpretation of data and reaching to the conclusion-

Observe the spark emissions of carbon steel sample. Make the records of structure and spark emissions of samples analyzed. The length of spark stream and form of the spark helps identify the carbon steel. With the help of records maintained, compare the spark emissions of unknown samples. Determine the carbon content of steel with the observation made.

Step 8- Inculcate good practice by making awareness at shop floor.

A bench grinder is a runs at very high speed which is around 3600rpm, so it is very much dangerous to used machine safely while conducting the experiment. Grinding

machines are used daily in a machine shop. To avoid injuries follow the safety precautions listed below-

1) Wear goggles for all grinding machine operations.
2) Check grinding wheels for cracks before mounting
3) Never operate grinding wheels at speeds in excess of the recommended speed.
4) Never adjust the work piece or work mounting devices when the machine is operating
5) Do not exceed recommended depth of cut for the grinding wheel or machine.
6) Remove work piece from grinding wheel before turning machine off.
7) Use proper wheel guards on all grinding machines.

Where are going to present this project to our college so they will understand and will motivate students to go for further study on same topic. We also made a manual so it will help anyone to conduct the same test.

5. RESULT & DISCUSSION:

With the lights dimmed, two photos and video shooting of each specimen were taken with a flash, perpendicular to the spark stream. A black backboard with an mm scale drawn on it was used to provide contrast with the spark stream.

The mm scale was used in conjunction with ImageJ software. Data was gathered using this ImageJ software in which photos of the sparks were uploaded. ImageJ uses drawing tools and references pixels to measure the length of lines drawn. The scale was set by drawing a line of a known distance, in this case an mm, and setting the number of pixels for that distance.[3]

The length was then measured by drawing a line down the centre of the spark stream and the software calculated the length and stored it in an Excel table. Some human judgment was made in this process to catch most of the sparks within the limits in order to make the measurements of the spark length and the angle of extremes.

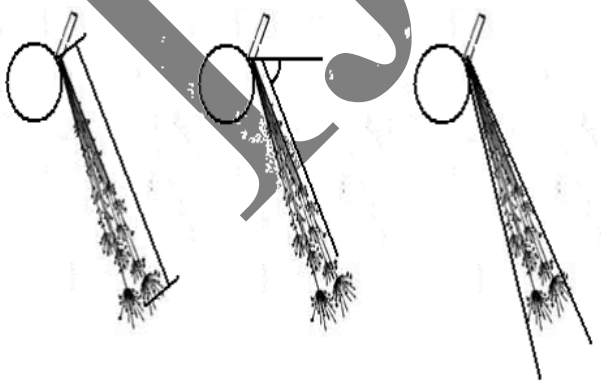

Fig.3 Measurements made using ImageJ on a typical pattern.

Table 2 - First Observation:-

SR. NO	TYPE OF METALS	LENGTH IN X-AXIS(L)	SPARK LENGTH SP = L/cos(40)	ANGLE OF EXTREME
1	C8	800mm	1044.38mm	17.76°
2	C18	760mm	992.16mm	20.32°
3	C40	750mm	979.11mm	23.42°
4	C45	710mm	926.89mm	25.54°
5	C55	690mm	900.78mm	27.68°
6	C95	520mm	678.85mm	32.12°

Table 3 - Second Observation:-

SR. NO.	TYPE OF METALS	LENGTH IN X-AXIS(L)	SPARK LENGTHSP = L/cos(40)	ANGLE OF EXTREME
1	C8	800mm+	1044.38mm+	18.32°
2	C18	780mm	1018.27mm	20.05°
3	C40	740mm	966.05mm	22.86°
4	C45	720mm	939.40mm	24.97°
5	C55	670mm	874.67mm	28.23°
6	C95	490mm	639.68mm	33.47°

Graphs:

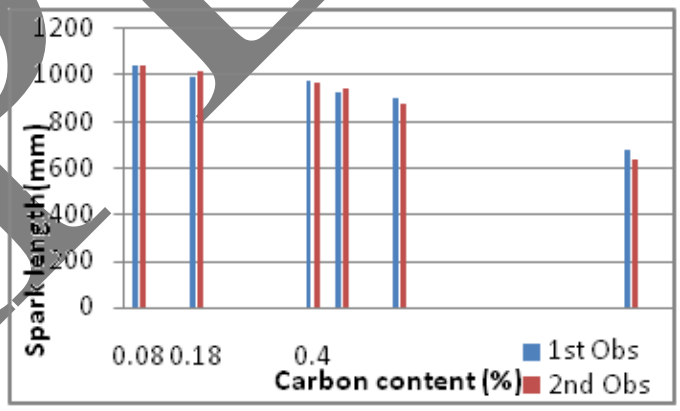

Fig.4 Graph of Carbon content vs. Spark length

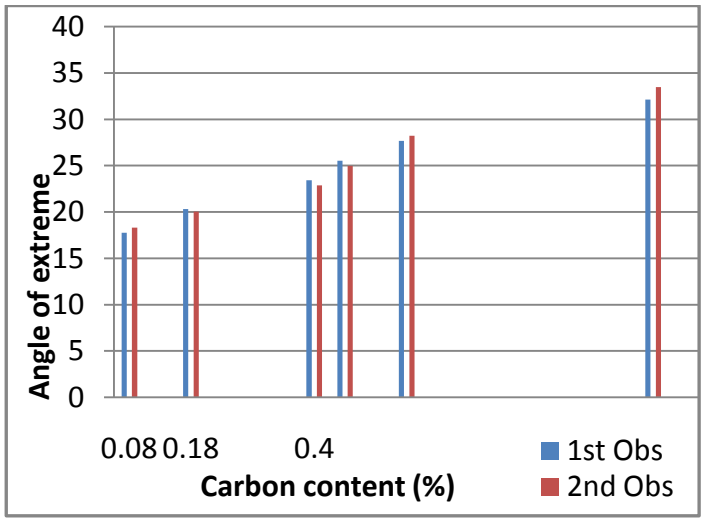

Fig.5 Carbon content vs. Angle of Extreme (°)

Fig.6 Testing of **C8** Material

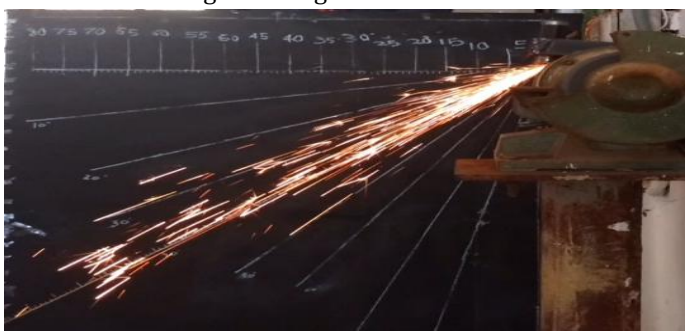

Fig.6 Testing of **C18** Material

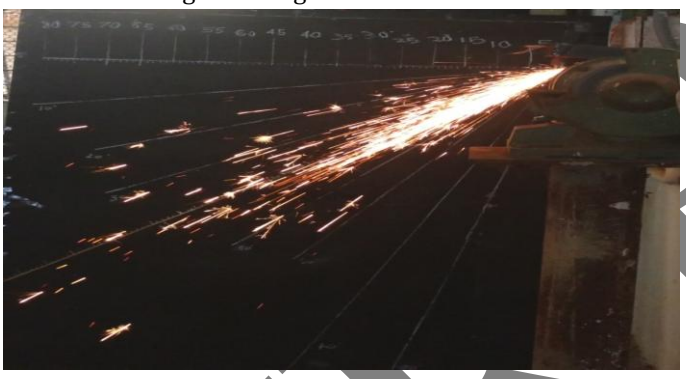

Fig.7 Testing of **C40** Material

Fig.8 Testing of **C45** Material

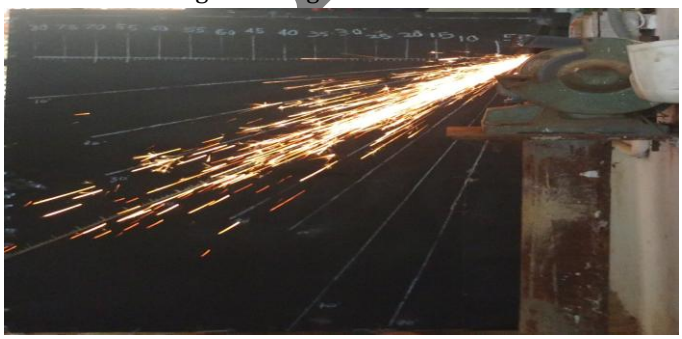

Fig.9 Testing of **C55** Material

Fig.10 Testing of **C95** Material

6. CONCLUSIONS:

Results from the above tests can be used as manual for small scale industries. One can fairly easily determine an unknown carbon steel sample specimen with the above test described. This database can be expanded in the future for more steels. Hence, it is a viable, cheap method of steel and cast iron determination and deserves further research.

7. FUTURE SCOPES:

1) USING THERMAL IMAGING CAMERA:

Initially, an idea to use an infrared thermometer to capture the temperature of the sparks coming off of the grinding wheel was attempted. This idea was quickly abandoned as the infrared thermometer takes an average temperature over a certain surface area. The surface area read was the specimen, the grinding wheel and grinding wheel housing. The temperatures gathered were erratic and showed no trends.Potential future research could use a thermal imaging camera. A thermal imaging camera focusing on the hottest point in the camera lens and capturing the image will hopefully be used next year. The image can, then, be uploaded onto a computer where the temperature can be calculated. A small preliminary study using a thermal imaging camera has already been attempted by focusing on the temperature of the sparks and the capture of the image. The sparks did not retain heat long enough for the camera to capture an image.[2]

2) PERMANENT CLAMPING OF FIXTURE ON GRINDER:

Permanent clamping of fixture on the grinding machine can be done. Due to permanent clamping basically the set up time can be reduced.

3) CHANGING TYPE OF LOCATORS:

If there is change in surface of object, different types of locators can be utilized. Flat locator can be used for location of flat machined surface of components. For supporting the cylindrical objects generally the drill bush locator can be utilized. Basically for any of the irregular

surfaces Jack Pin Locator can be used to accommodate work pieces having variation in surface textures.

4) USING HD CAMERA :

There could be another future work we could make by utilization of a high speed camera. In order to acquire clear images of sparks emitting at high speed, the high speed camera of per second 200 images is adopted. Further, for cutting materials stably and reducing a cutting damage into the minimum, the air cylinder of low friction to grinding wheel is adopted. With this equipment composition, the images of 200 flames are captured in between 1 second, and the explosion sparks by the carbon included in carbon steel, and carbon content are calculated by imaging processing computer in about 10 seconds.

REFERENCES:

1) V.D. Kodagire, *Material Science and Metallurgy*, (37th Edition), pg no. 304
2) Daniel Goodey & Jan Brink, Vol.13 No.3, *Material using a thermal imaging camera* (2015).
3) ImageJ. *Image processing and analysis in Java*, http://rsbweb.nih.gov/ij/